TROPICAL RAINFALL MEASURING MISSION SCIENCE DATA AND INFORMATION SYSTEM

Interface Control Specification Between the Tropical Rainfall Measuring Mission Science Data and Information System (TSDIS) and the TSDIS Science User (TSU)

TSDIS-P907

Volume 4: File Specifications for TSDIS Products - Level 2 and Level 3

Release 3

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This is the fourth volume of the TSDIS - TSU ICS. This volume specifies Level 2 and Level 3 file formats. It was written based on the TRMM Science Requirements, Version 1 and 2 algorithm descriptions and personal communications with the algorithm developers. It has been updated using information contained in the Version 2 algorithm descriptions and communications with algorithm developers received before May 20, 1996. No information received after May 20, 1996 was included in this version of the file specifications.

The sections that specify the metadata will change as the TSDIS metadata are defined. Currently, all Level 2 and 3 products use the Hierarchical Data Format (HDF) except 2A-52, which is in ASCII format. Level 2 satellite data products use the EOSDIS Swath Structure. Level 3 satellite data products use the EOSDIS Planetary Grid Structure. Level 2 and 3 Ground Validation (GV) radar data products use the TSDIS-defined Radar Grid Structure, except for 2A-52. The explanations of the HDF, Swath Structure, Planetary Grid Structures and Radar Grid Structure are given in Section 2 of Volume 3 of the TSDIS -TSU ICS, which is the Level 1 File Specifications. The formatting conventions, including values for missing data, are described in Section 3 of Volume 3 of the TSDIS -TSU ICS.

1. LEVEL 2 PRODUCTS

Level 2 products are instantaneous rainfall and surface cross section products retrieved from Level 1 data. There are 11 Level 2 TRMM products for satellite data and ground validation (GV) data. For satellite data, only the TRMM Microwave Imager (TMI) and Precipitation Radar (PR) have Level 2 data products; there is no Level 2 data product for the Visible and Infrared Scanner (VIRS). Ground validation data include GV radar data and data from rain gauges and disdrometers, which are located at the same sites as the GV radars.

1.1 TRMM MICROWAVE IMAGER (TMI)

There is only one Level 2A data product for TMI, 2A-12 - TMI Profiling (PI: Dr. Christian Kummerow). The granule size is one orbit plus 50 scan lines of pre-orbit overlap and 50 scan lines of post-orbit overlap. The following parameters are used in describing the formats:

- nscan: the number of scans within one granule (2891+50 + 50 =2991).
- npixel: the number of high resolution pixels within one scan line (208).
- nlayer: the number of profiling layers within one pixel (14).
- ngeo: the number of geolocation data (2).

1.1.1 2A-12 - TMI Profiling

2A-12, “TMI Profiling”, generates vertical hydrometer profiles on a pixel by pixel basis. For each pixel, cloud liquid water, precipitation water, cloud ice water, precipitation ice, and latent heating are given at 14 vertical layers. The surface rainfall and the associated confidence indicator will also be computed. The format of this product is designed in consultation with the TMI algorithm scientists. Figure 1.1.1-1 shows the structure of the 2A-12 product in terms of the component objects and sizes.

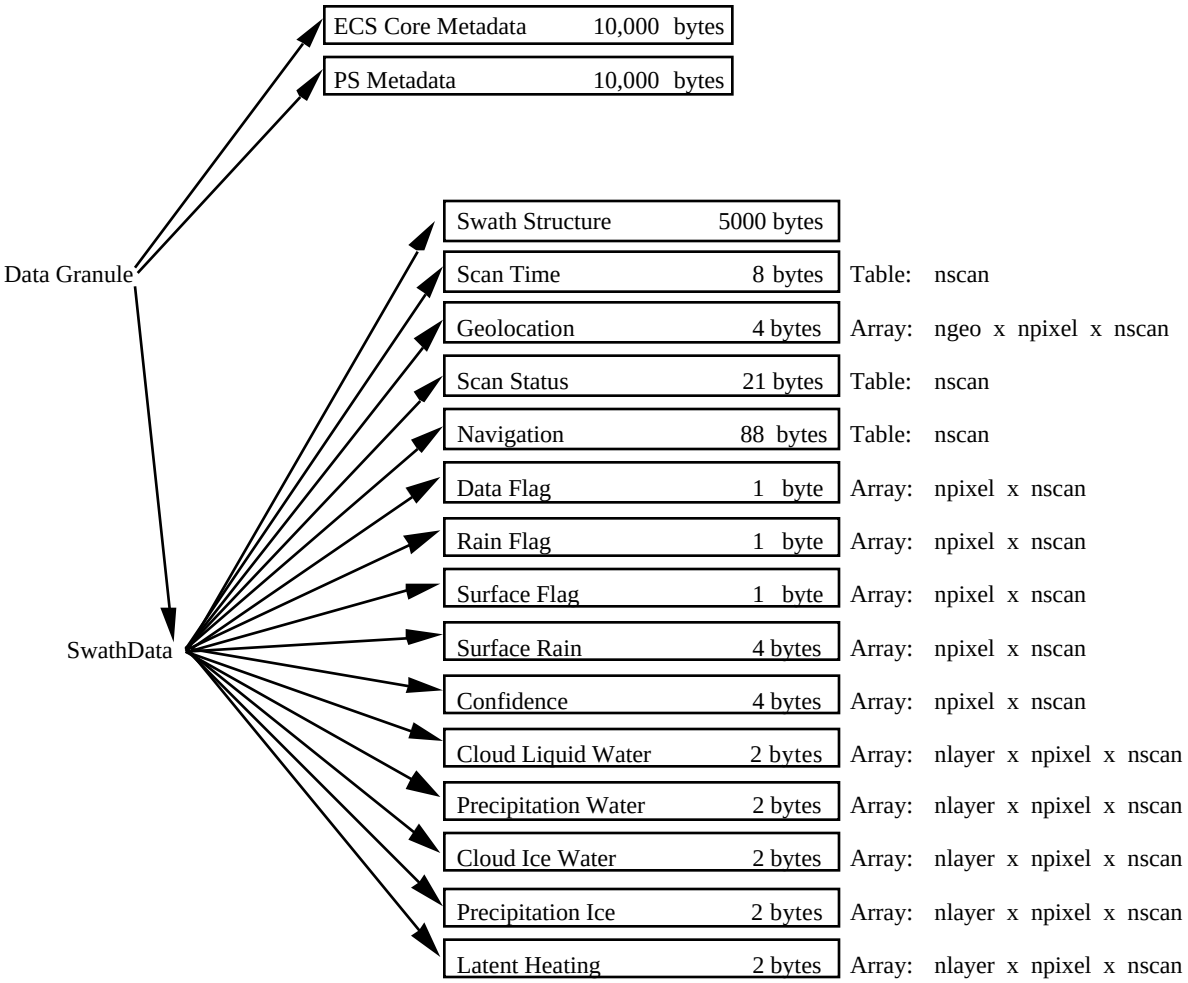


Figure 1.1.1-1
Data Format Structure for 2A-12, TMI Profiling

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):

ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications

SwathStructure (Attribute, 5000-byte character)
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Scan Time (Vdata Table, record size 8 bytes, nscan records):
The Scan Time is the time associated with each scan. Table 1.1.1-1 gives the description of the content and format. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3.

Table 1.1.1-1
Scan Time

Name	Format	Description
Year	1-byte integer	2-digit year, e.g., 98 for 1998 or 0 for 2000
Month	1-byte integer	The month of the Year
Day of Month	1-byte integer	The day of the Month
Hour	1-byte integer	The hour (UTC) of the Day
Minute	1-byte integer	The minute of the Hour
Second	1-byte integer	The second of the Minute
Day of Year	2-byte integer	The day of the Year

Geolocation (SDS, array size ngeo x npixel x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are numbers of pixels and scans. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180^0 meridian is assigned to the western hemisphere.

Scan Status (Vdata, record size 21 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number are shown in Table 1.1.1-2. All bytes in the Scan Status are copied from 1B-11 including the Missing byte. 2A-12 should reset the Missing byte if it determines data is missing or there is no-rain.

Table 1.1.1-2
Scan Status
(Vdata, record size 21 bytes, nscan records)

Name	Format	Description
Missing	1-byte integer	Missing indicates whether information is contained in the scan data. This byte is copied from 1B-11 and possibly reset by 2A-12. The values are: 0 Scan data elements contain information 1 Scan was missing in the telemetry data 2 Scan data contains no elements with rain
Validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (Bit 0 = 1 or bit 1 = 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)
QAC	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	1-byte integer	Geolocation Quality is broken into 8 bit flags. Each bit = 0 if the status is good but the bit = 1 if the status is bad. Each bit flag is listed below, arranged in approximate descending order of severity: Bit Meaning if bit = 1 0 Very bad geolocation results: Latitudes, longitudes, or other parameters out of bounds, or scan missed Earth (excluding CERES deep-sky calibration mode) 1 Lat/lon do not vary smoothly from scan to scan. Details **TBD**Indicates problem with either current or previous scan, but cannot discriminate between them. 2 The difference between the roll/pitch/yaw in consecutive ACS packets was greater than **TBD** range. 3 Roll/pitch/yaw out of normal range. Range **TBD.** 4 Satellite undergoing maneuvers. (Geolocation is less accurate during maneuvers.) 5 Questionable Ephemeris or questionable UTCF, including use of predicted ephemeris for quicklook. 6 Geolocation calculations failed. Flags whether initialization failed, or whether geolocation processing failed, due to, e.g., error in allocating memory. 7 Geolocation quality control not be carried out (e.g., due to error

Name	Format	Description
		in initialization of QA parameters or failure to write QA verification intermediate product).

Table 1.1.1-2 (continued)
Scan Status
(Vdata, record size 21 bytes, nscan records)

Name	Format	Description
Data Quality [9]	9 X 1-byte integer	The Quality of Channel Data for a given channel on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata. Quality is given for each channel in the order of the channel number.
Current Spacecraft Orientation	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
TMI Instrument Status	1-byte integer	Bit Meaning 00 Receiver Status (1=ON, 0=OFF) 01 Spin-up Status (1=ON, 0=OFF) 02 Spare Command 1 Status 03 Spare Command 2 Status 04 1 Hz Clock Select (1=A, 0=B) 05 Spare Command 3 Status 06 Spare Command 4 Status 07 Spare Command 5 Status
Fractional Orbit Number	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix D in Volume 3 of ICS, Level 1 File Specifications

Data Flag (SDS, array size npixel x nscan, 1-byte integer):
The Data Flag indicates the quality of data. If values are larger than zero, the data quality is good. If values are less than zero, the data quality is bad and the specific value is used to indicate various error conditions. The values are **TBD**.

Rain Flag (SDS, array size npixel x nscan, 1-byte integer):
The Rain Flag indicates if rain is present. If rain is present, the value will be larger than zero. The value will be less than zero if the pixel is pre-screened as non-raining; the exact value is used to identify the screen itself.

Surface Flag (SDS, array size npixel x nscan, 1-byte integer):
The Surface Flag indicates the type of surface and has the following values:

0: ocean;

1: land;

2: coast;

3: other.

Surface Rain (SDS, array size npixel x nscan, 4-byte float):
The Surface Rain is the instantaneous rain rate (mm h^{-1}) at the surface for each pixel. It ranges between 0.0 and 3000.0 mm/h.

Confidence (SDS, array size npixel x nscan, 4-byte float):
The Confidence is that associated with the surface rain. It is measured as an rms deviation in temperatures with units in degrees (K). The data range is 0.0 to 300.0K

Cloud Liquid Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the cloud liquid water content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer.

Precipitation Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the precipitation water content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer.

Cloud Ice Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the cloud ice water content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer.

Precipitation Ice (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the precipitation content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer.

Latent Heating (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the latent heating release (^{0}C/day) for each pixel at 14 layers. It is multiplied by 10 and stored as a 2-byte integer. Ranges are -256 deg/hour to 256 deg/hour.

1.2 PRECIPITATION RADAR (PR)

There are three level 2A products for PR, 2A-21 - Surface Cross Section (PI: Dr. Robert Meneghini), 2A-23 - PR Qualitative (PI: Dr. Jun Awaka), and 2A-25 - PR Profile (PI: Dr. Toshio Iguchi). The formats of these products are based on the Version 2 algorithm descriptions and consultation with PR algorithm scientists. The granule sizes for all Level 2 PR products are one orbit. The following parameters are used in describing the formats:

- nscan: the number of PR scans within one granule (9150).
- nray: the number of rays within one PR scan line (49).
- ngeo: the number of geolocation data (2).
- ncell1: the number of radar range cells at which the rain rate is estimated (80).
- ncell2: the number of radar range cells at which the Z-R parameters are output (5)
- nmeth: the number of methods used (2)

1.2.1 2A-21 - Surface Cross Section

2A-21, "Surface Cross Section," computes the normalized surface cross section. If rain is present, it will also compute path attenuation and its associated reliability factor. Figure 1.2.1-1 shows the structure of the 2A-21 product in terms of the component objects and their sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS.
See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS.
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

SwathStructure (Attribute, 5000-byte character)
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

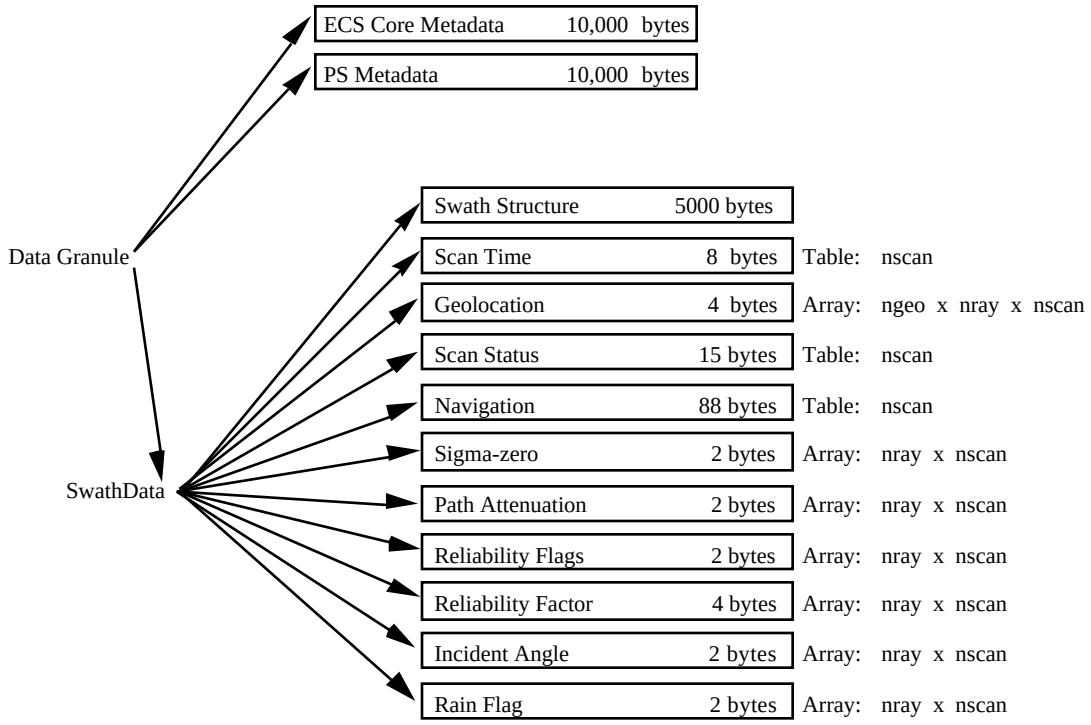


Figure 1.2.1-1
Data Format Structure for 2A-21, Surface Cross Section

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following, Table 1.2.1-1.

Table 1.2.1-1
Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are numbers of pixels and scans. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180^0 meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number as shown in Table 1.2.1-2. All bytes in Scan Status are copied from 1B-21 including the Missing byte. 2A-21 should reset the Missing byte if it determines data is missing or there is no-rain.

Table 1.2.1-2
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Missing	1-byte integer	Missing indicates whether information is contained in the scan data. This byte is copied from 1B-21 and possibly reset by 2A-21. The values are: 0 Scan data elements contain information 1 Scan was missing in the telemetry data 2 Scan data contains no elements with rain
Validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (other than 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)
QAC	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	1-byte integer	Geolocation Quality is broken into 8 bit flags. Each bit = 0 if the status is good but the bit = 1 if the status is bad. Each bit flag is listed below, arranged in approximate descending order of severity: Bit Meaning if bit = 1 0 Very bad geolocation results: Latitudes, longitudes, or other parameters out of bounds, or scan missed Earth (excluding CERES deep-sky calibration mode) 1 Lat/lon do not vary smoothly from scan to scan. Details **TBD**. Indicates problem with either current or previous scan, but cannot discriminate between them. 2 The difference between the roll/pitch/yaw in consecutive ACS packets was greater than **TBD** range. 3 Roll/pitch/yaw out of normal range. Range **TBD.** 4 Satellite undergoing maneuvers. (Geolocation is less accurate during maneuvers.) 5 Questionable Ephemeris or questionable UTCF, including use of predicted ephemeris for quicklook. 6 Geolocation calculations failed. Flags whether initialization failed, or whether geolocation processing failed, due to, e.g., error in allocating memory. 7 Geolocation quality control not be carried out (e.g., due to error in initialization of QA parameters or failure to write QA

Name	Format	Description
		verification intermediate product).

Table 1.2.1-2 (continued)
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Data Quality	1-byte integer	The Quality of Data on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata.
Current Spacecraft Orientation	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
PR Mode	1-byte integer	Value Meaning 1 Observation Mode 2 Internal Calibration Mode 3 External Calibration Mode 4 Analysis Mode 5 Stand-by Mode
PR Status 1	1-byte integer	A description of PR sensor status such as FCIF Component used (A or B) and Initialization in Onboard Surface Search Algorithm. Details are **TBD** by NASDA.
PR Status 2	1-byte integer	See PR Status 1 description.
Fractional Orbit Number	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix D in Volume 3 of ICS, Level 1 File Specifications

Sigma-zero (SDS, array size nray x nscan, 2-byte integer):
The Sigma-zero is the normalized surface cross section. It ranges from -50.00 to 20.00 dB and is multiplied by 100 and stored as a 2-byte integer.

Path Attenuation (SDS, array size nray x nscan, 2-byte integer):
This is the estimate of path-attenuation when rain is present. It ranges from 0.00 to 50.00 dB and is multiplied by 100 and stored as a 2-byte integer.

Reliability Flags (SDS, array size nray x nscan, 2-byte integer):
Reliability Flags holds various information in the form of single digit integer flags. The 2-byte integer is expressed in the form vwxyz where v, w, x, y, and z are integers between 0 and 9 (v must be 0, 1, or 2). Each digit has the following definition:

- v = Miscellaneous information (e.g., land/sea/coast; whether a problem exists with the reference data set; missing data, etc.) Details are TBD.
- w = Path attenuation estimate is:
  - 0 - unreliable
  - 1 - marginally reliable
  - 2 - reliable
  - 3 - lower bound
  - 9 - no-rain case
- x = Information about surface detection validity (including whether surface tracking is in the ‘locked’ or ‘unlocked’ state). Details are TBD.
- y = Indicator of which surface reference estimate has been chosen (temporal or spatial). Details are TBD.
- z = TBD

Reliability Factor (SDS array size nray x nscan, 4-byte float):
The Reliability Factor is the ratio of the estimated value of path attenuation to the standard deviation associated with the mean value of the reference estimate. This ratio will likely not exceed 5.0 and is unitless.

Incident Angle (SDS, array size nray x nscan, 2-byte integer):
The Incident Angle is the angle, in degrees, between the PR nadir and the radar beam. It ranges from -30.0 to +30.0 degrees and is multiplied by 10 and stored as a 2-byte integer.

Rain Flag (SDS, array size nray x nscan, 2-byte integer):
The Rain Flag has the following values:

0: no rain;

1: rain present.

1.2.2 2A-23 - PR Qualitative

2A-23, "PR Qualitative", produces a Rain/No-rain flag. If rain is present, this algorithm will detect the bright band, determine the heights of the bright band and the storm, and classify rain types. Figure 1.2.2-1 shows the structure of the 2A-23 product in terms of the component objects and their sizes.

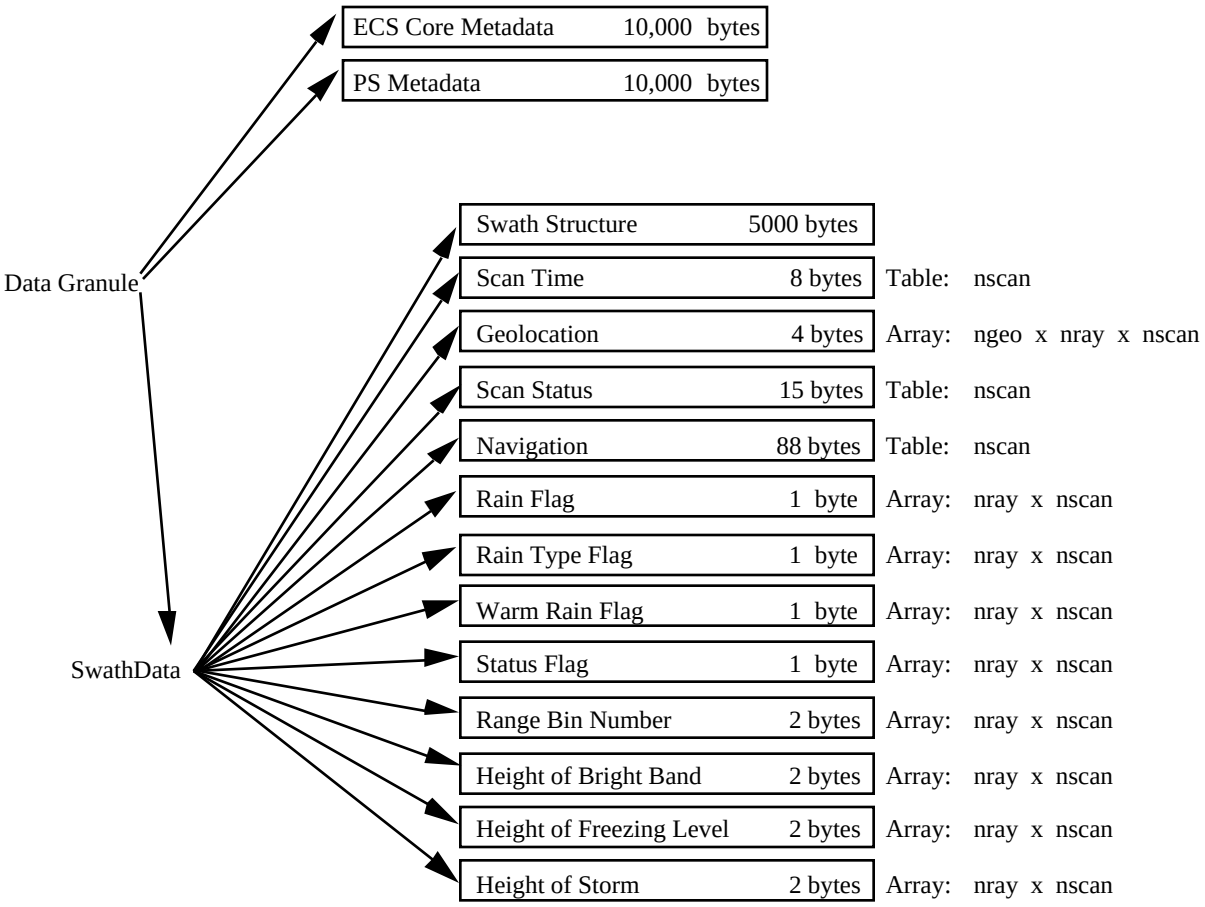


Figure 1.2.2-1
Data Format Structure for 2A-23, PR Qualitative

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS.

See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS.
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

SwathStructure (Attribute, 5000-byte character)
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Scan Time (Vdata Table, record size 8 bytes, nscan records)
See the following, Table 1.2.2-1.

Table 1.2.2-1
Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are numbers of pixels and scans. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180^0 meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number as shown in Table 1.2.2-2. All bytes in Scan Status are copied from 1B-21 including the Missing byte. 2A-23 should reset the Missing byte if it determines data is missing or there is no-rain.

Table 1.2.2-2
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Missing	1-byte integer	Missing indicates whether information is contained in the scan data. This byte is copied from 1B-21 and possibly reset by 2A-23. The values are: 0 Scan data elements contain information 1 Scan was missing in the telemetry data 2 Scan data contains no elements with rain
Validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (other than 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)
QAC	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	1-byte integer	Geolocation Quality is broken into 8 bit flags. Each bit = 0 if the status is good but the bit = 1 if the status is bad. Each bit flag is listed below, arranged in approximate descending order of severity: Bit Meaning if bit = 1 0 Very bad geolocation results: Latitudes, longitudes, or other parameters out of bounds, or scan missed Earth (excluding CERES deep-sky calibration mode) 1 Lat/lon do not vary smoothly from scan to scan. Details **TBD**. Indicates problem with either current or previous scan, but cannot discriminate between them. 2 The difference between the roll/pitch/yaw in consecutive ACS packets was greater than **TBD** range. 3 Roll/pitch/yaw out of normal range. Range **TBD.** 4 Satellite undergoing maneuvers. (Geolocation is less accurate during maneuvers.) 5 Questionable Ephemeris or questionable UTCF, including use of predicted ephemeris for quicklook. 6 Geolocation calculations failed. Flags whether initialization failed, or whether geolocation processing failed, due to, e.g., error in allocating memory. 7 Geolocation quality control not be carried out (e.g., due to error

Name	Format	Description
		in initialization of QA parameters or failure to write QA verification intermediate product).

Table 1.2.2-2 (continued)
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Data Quality	1-byte integer	The Quality of Data on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata.
Current Spacecraft Orientation	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
PR Mode	1-byte integer	Value Meaning 1 Observation Mode 2 Internal Calibration Mode 3 External Calibration Mode 4 Analysis Mode 5 Stand-by Mode
PR Status 1	1-byte integer	A description of PR sensor status such as FCIF Component used (A or B) and Initialization in Onboard Surface Search Algorithm. Details are **TBD** by NASDA.
PR Status 2	1-byte integer	See PR Status 1 description.
Fractional Orbit Number	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix D in Volume 3 of ICS, Level 1 File Specifications

Rain Flag (SDS, array size nray x nscan, 1-byte integer):
The Rain Flag is set as follows:

0: no rain;
1: rain present.

Rain Type Flag (SDS, array size nray x nscan, 1-byte integer):
The Rain Type Flag is set as follows:

1: stratus;
2: cumulus;
3: other.

Warm Rain Flag (SDS, array size nray x nscan, 1-byte integer):
The Warm Rain Flag is set as follows:

0: warm rain is not detected;
1: there may be "warm" rain;
2: warm rain is detected (with high confidence).

Status Flag (SDS, array size nray x nscan, 1-byte integer):
The Status Flag indicates whether the data are obtained over sea or land and the quality of 2A-23 product data. It is set as follows:

0: good (over sea);
1: maybe good (over sea);
2: doubtful (over sea);
10: good (over land);
11: maybe good (over land);
12: doubtful (over land);

Range Bin Number (SDS, array size nray x nscan, 2-byte integer):
The Range Bin Number is that corresponding to the height of bright band.

Height of Bright Band (SDS, array size nray x nscan, 2-byte integer):
The Height of Bright Band is defined as above mean sea level in meters. If the bright band is not detected, the height is set to zero.

Height of Freezing Level (SDS, array size nray x nscan, 2-byte integer):
The Height of Freezing Level is the estimated height of the 0^0C isotherm above mean sea level in meters.

Height of Storm (SDS, array size nray x nscan, 2-byte integer):
The Height of Storm is that above sea level in meters. In the absence of precipitation, this value is set to zero.

1.2.3 2A-25 - PR Profile

2A-25, "PR Profile", produces an estimate of vertical rainfall rate profile for each radar beam. The rainfall rate estimate is given at each resolution cell of the PR radar. To compare with ground-based radar data, the attenuation corrected Z profile is also given. The average rainfall rate between

the two pre-defined altitudes is calculated for each beam position. Other output data include parameters of Z-R relationships at each resolution cell, integrated rain rate of each beam, range bin numbers of rain layer boundaries, and many intermediate parameters. Figure 1.2.3-1 shows the structure of the 2A-25 product in terms of the component objects and their sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

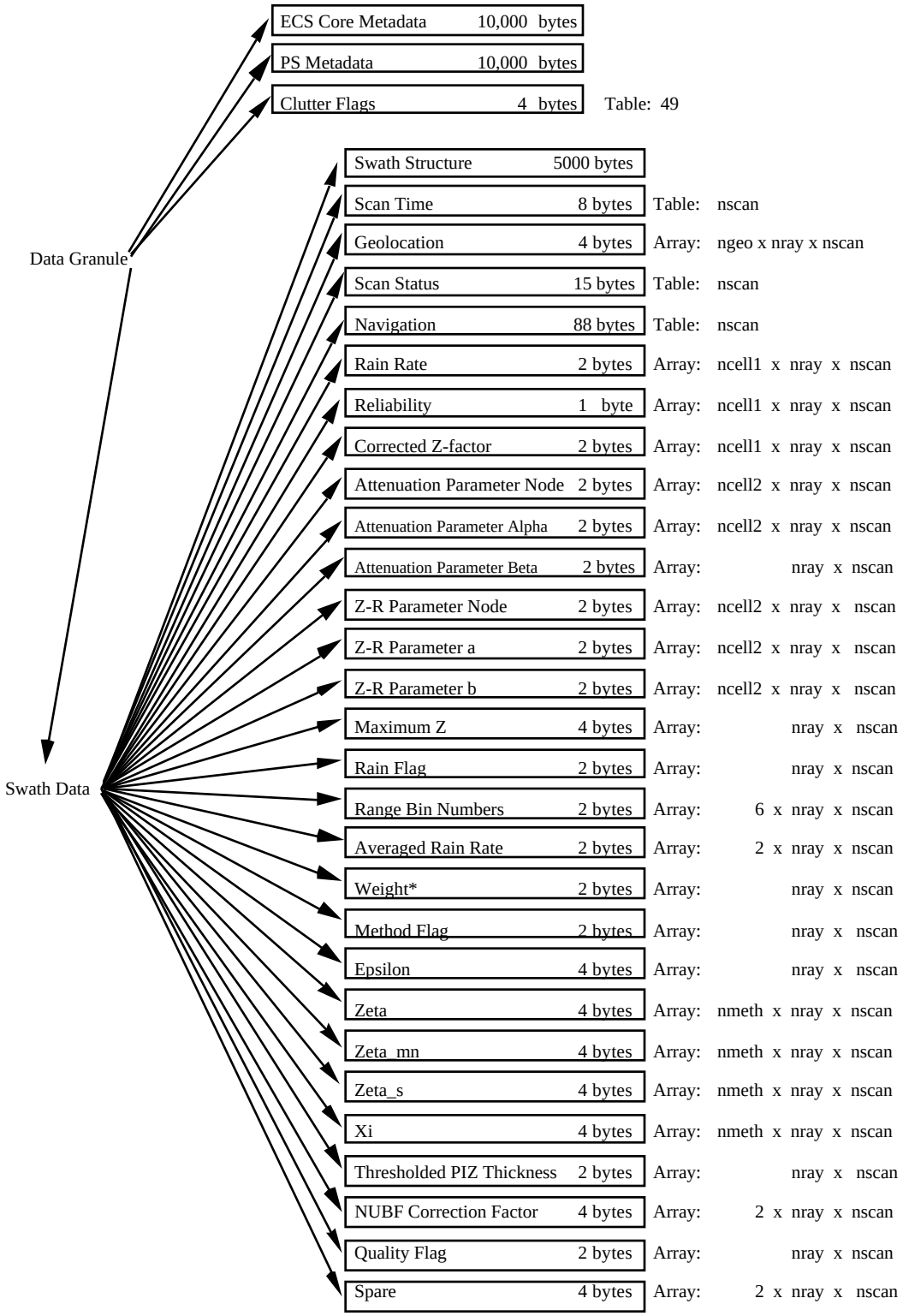
PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Clutter Flags (Vdata Table, record size 4 bytes, 49 records):
The Clutter Flags are identical to the clutter information in 1B-21 in the Ray Header. See Table 1.2.3-1.

SwathStructure (Attribute, 5000-byte character)
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Table 1.2.3-1
Clutter Flags

Name	Format	Description
Mainlobe Clutter Edge	1-byte integer	Absolute value of the difference in Range bin Numbers between the detected surface and the edge of the clutter from the mainlobe.
Sidelobe Clutter Range[3]	3 x 1-byte integer	Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter positon from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.



* If the buffer method is used in the final version, the output of weighting function may be replaced by epsilon_0.

Figure 1.2.3-1
Data Format Structure for 2A-25, PR Profile

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following, Table 1.2.3-2.

Table 1.2.3-2
Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are pixel and scan. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180^0 meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number as shown in Table 1.2.3-2. All bytes in the Scan Status are copied from 1B-21 including the Missing byte. 2A-25 should reset the Missing byte if it determines data is missing or there is no-rain.

Table 1.2.3-2
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Missing	1-byte integer	Missing indicates whether information is contained in the scan data. This byte is copied from 1B-21 and possibly reset by 2A-25. The values are: 0 Scan data elements contain information 1 Scan was missing in the telemetry data 2 Scan data contains no elements with rain
Validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (other than 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)

Table 1.2.3-2 (continued)
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
QAC	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	1-byte integer	Geolocation Quality is broken into 8 bit flags. Each bit = 0 if the status is good but the bit = 1 if the status is bad. Each bit flag is listed below, arranged in approximate descending order of severity: Bit — Meaning if bit = 1 0 — Very bad geolocation results: Latitudes, longitudes, or other parameters out of bounds, or scan missed Earth (excluding CERES deep-sky calibration mode) 1 — Lat/lon do not vary smoothly from scan to scan. Details **TBD**. Indicates problem with either current or previous scan, but cannot discriminate between them. 2 — The difference between the roll/pitch/yaw in consecutive ACS packets was greater than **TBD** range. 3 — Roll/pitch/yaw out of normal range. Range **TBD.** 4 — Satellite undergoing maneuvers. (Geolocation is less accurate during maneuvers.) 5 — Questionable Ephemeris or questionable UTCF, including use of predicted ephemeris for quicklook. 6 — Geolocation calculations failed. Flags whether initialization failed, or whether geolocation processing failed, due to, e.g., error in allocating memory. 7 — Geolocation quality control not be carried out (e.g., due to error in initialization of QA parameters or failure to write QA verification intermediate product).
Data Quality	1-byte integer	The Quality of Data on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata.
Current Spacecraft Orientation	1-byte integer	Value — Meaning 0 — +x forward 1 — -x forward 2 — -y forward 3 — Inertial - CERES Calibration 4 — Unknown Orientation
Current ACS Mode	1-byte integer	Value — Meaning 0 — Standby 1 — Sun Acquire 2 — Earth Acquire 3 — Yaw Acquire 4 — Nominal 5 — Yaw Maneuver 6 — Delta-H (Thruster) 7 — Delta-V (Thruster) 8 — CERES Calibration
Yaw Update Status	1-byte integer	Value — Meaning 0 — Inaccurate

Name	Format	Description
		1 Indeterminate 2 Accurate

Table 1.2.3-2 (continued)
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
PR Mode	1-byte integer	Value Meaning 1 Observation Mode 2 Internal Calibration Mode 3 External Calibration Mode 4 Analysis Mode 5 Stand-by Mode
PR Status 1	1-byte integer	A description of PR sensor status such as FCIF Component used (A or B) and Initialization in Onboard Surface Search Algorithm. Details are **TBD** by NASDA.
PR Status 2	1-byte integer	See PR Status 1 description.
Fractional Orbit Number	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix D in Volume 3 of ICS, Level 1 File Specifications

Rain Rate (SDS, array size ncell1 x nray x nscan, 2-byte integer):
This is the estimate of rain rate at the radar range gates from 0 to 20 km. It ranges from 0.0 to 3000.0 mmh^{-1} and is multiplied by 10 and stored as a 2-byte integer.

Reliability (SDS, array size ncell1 x nray x nscan, 1-byte integer):
The Reliability is that for estimated rain rates at the radar range gates from 0 to 20 km. It ranges from 0 to 255. If data are missing, the reliability will be set as 10000000 in binary. The other values are **TBD**.

Corrected Z-factor (SDS, array size ncell1 x nray x nscan, 2-byte integer):
This is the attenuation corrected Z-factor at the radar range gates from 0 to 20 km. It ranges from 0.1 to 80.0 dB of mm^6 m^{-3} and is multiplied by 10 and stored as a 2-byte integer.

Attenuation Parameter Node (SDS, array size ncell2 x nray x nscan, 2-byte integer):
The Attenuation Parameter Node gives the range bin numbers of the nodes at which the values of Attenuation Parameter Alpha are given (see below). The values of Alpha between the nodes are linearly interpolated. This variable ranges from 0 and 79 and is unitless.

Attenuation Parameter Alpha (SDS, array size ncell2 x nray x nscan, 2-byte integer):
The attenuation parameter Alpha (α) relates the attenuation coefficient, k (dB/km) to the Z-factor: $k = \alpha Z^{\beta}$. α is computed at ncell2 radar range gates for each ray. It ranges from 0.000100 to 0.002000 and is multiplied by 10^6 and stored as a 2-byte integer.

Attenuation Parameter Beta (SDS, array size nray x nscan, 2-byte integer):
The Attenuation Parameter Beta (β) relates the attenuation coefficient, k (dB/km) to the Z-factor: $k = \alpha Z^{\beta}$. β is computed at ncell2 radar range gates for each ray. It ranges from 0.500 to 2.000 and is multiplied by 10^3 and stored as a 2-byte integer.

Z-R Parameter Node (SDS, array size ncell2 x nray x nscan, 2-byte integer):
The Z-R Parameter Node gives the range bin numbers of the nodes at which the Z-R parameters "a" and "b" are given (see below). The values of a and b between the nodes are linearly interpolated. This variable ranges from 0 and 79 and is unitless.

Z-R Parameter a (SDS, array size ncell2 x nray x nscan, 2-byte integer):
Parameter a for Z-R relationship ($R=aZ^b$) is determined from the rain type and the height relative to the freezing level, the non-uniformity parameter (ξ) and the correction factor (ε) for the surface reference technique. a is computed at 10 radar range gates for each ray. It ranges from 0.0050 to 0.2000 and is multiplied by 10^4 and stored as a 2-byte integer.

Z-R Parameter b (SDS, array size ncell2 x nray x nscan, 2-byte integer):
Parameter b for Z-R relationship ($R=aZ^b$) is determined from the rain type and the height relative to the freezing level, the non-uniformity parameter (ξ) and the correction factor (ε) for the surface reference technique. b is computed at 10 radar range gates for each ray. It ranges from 0.500 to 1.000 and is multiplied by 10^3 and stored as a 2-byte integer.

Maximum Z (SDS, array size nray x nscan, 4-byte float):
This is the maximum value of measured reflectivity at each IFOV. It ranges from 0.0 to 100.0 dBz.

Rain Flag (SDS, array size nray x nscan, 2-byte integer):
The Rain Flag indicates rain or no rain status and the rain type assumed in rain rate retrieval. The values are **TBD**.

Range Bin Numbers (SDS, array size 6 x nray x nscan, 2-byte integer):
This array gives the Range Bin Number of various quantities for each ray in every scan. The definitions are:

- top range bin number of the interval that is processed as meaningful data in 2A-25
- bottom range bin number of the interval that is processed as meaningful data in 2A-25
- actual surface range bin number
- range bin number of the bright band if it exits
- range bin number at which the path-integrated Z-factor first exceeds the given threshold
- range bin number at which the measured Z-factor is maximum

The Range Bin Numbers in this algorithm are different from the NASDA definition of Range Bin Number described in the ICS, Volume 3. The Range Bin Numbers in the algorithm range from 0 to 79 and have an interval of 250m. The earth ellipsoid is defined as range bin 79.

Averaged Rain Rate (SDS, array size 2 x nray x nscan, 2-byte integer):
There are two kinds of Average Rain Rate. The first one is the average rain rate for each ray between the two predefined heights of 2 and 4 km. The other is **TBD.** It will be either the average for a different height range or the estimate of the surface rain rate. They range from 0.0 to 3000.0 mm h^{-1} and is multiplied by 10 and stored as a 2-byte integer.

Weight (SDS, array size nray x nscan, 2-byte integer):
The Weight is the weighting function of an estimate of the path-integrated attenuation and its reliability. It ranges from 0.000 to 1.000 and is multiplied by 10^3 and stored as a 2-byte integer.

Method Flag (SDS, array size nray x nscan, 2-byte integer):
This flag indicates which method is used to derive the rain rate. It ranges from 0 to 10. The names of methods are **TBD**.

Epsilon (SDS, array size nray x nscan, 4-byte float):

The Epsilon (ε) is the correction factor for the surface reference. It ranges from 0.0 to 100.0.

Zeta (SDS, array size nmeth x nray x nscan, 4-byte float):

The Zeta (ζ) roughly represents the rain rate integrated along the ray using two different methods. It ranges from 0.0 to 100.0 and is unitless.

Zeta_mn (SDS, array size nmeth x nray x nscan, 4-byte float):

Zeta_mn (ζ_{mn}) is the average of zeta (ζ) in the vicinity of each beam position (average over three scans and three IFOVs). It is calculated using two methods. It ranges from 0.0 to 100.0 and is unitless.

Zeta_sd (SDS, array size nmeth x nray x nscan, 4-byte float):

Zeta_sd (ζ_{sd}) is the standard deviation of zeta (ζ) in the vicinity of each beam position (using three scans and three IFOVs). It is calculated using two methods. It ranges from 0.0 to 100.0 and is unitless.

Xi (SDS, array size nmeth x nray x nscan, 4-byte float):
The Xi is the normalized standard deviation defined as Zeta_sd/Zeta_m. When Zeta_m takes on small values (or zero) Xi is set to 99.0. It is calculated using two methods. Xi ranges from 0.0 to 99.0 and is unitless.

Thresholded PIZ Thickness (SDS, array size nray x nscan, 2-byte integer):
This is the number of range bins (250m resolution) between the highest range at which rain is certain and the range at which the Path-Integrated Z-factor (PIZ) first exceeds a threshold. This is a unitless quantity and it ranges from 0 to 79.

NUBF Correction Factor (SDS, array size 2 x nray x nscan, 4-byte float):
The Non-Uniform Beam Filling (NUBF) Correction Factor is used as a correction to reflectivity and attenuation calculations. The two NUBF Correction Factors are given for the K-Z and Z-R relations. The ranges are 1.0 to 2.0 and .9 to 1.0, respectively. Both are unitless quantities.

Quality Flag (SDS, array size nray x nscan, 1-byte integer)
This quality flag gives the overall error that affects the entire angle bin data, such as the error associated with the non-uniform beam filling effect and the surface reference reliability. It ranges from 0 to 255. If data are missing, the reliability will be set as 10000000 in binary. The other values are **TBD**.

Spare (SDS, array size 2 x nray x nscan, 4-byte float):
Contents and ranges are **TBD** by algorithm developer.

1.3 TMI AND PR COMBINED

There is one combined algorithm for TMI and PR, 2B-31 ¾ TRMM Combined (PI: Dr. Ziad Haddad). The format of the product is based on the TRMM Science Requirements and algorithm description. The granule size is one orbit and has a PR based geometry. The following parameters are used in describing the formats:

- nscan: the number of PR scans within one granule (9150).
- nray: the number of rays within one PR scan line (49).
- ngeo: the number of geolocation data (2).
- Nradarrange: the number of radar range gates, up to about 15 km from the earth ellipsoid (80).

1.3.1 2B-31 - TRMM Combined

2B-31, "TRMM Combined", derives vertical hydrometeor profiles using data from PR radar and the 10Ghz channels of the TMI. It also computes the correlation-corrected mass-weighted mean drop diameter, the correlation-corrected relative spread of mass-weighted mean drop diameter, the correction made to the input path-integrated attenuation estimate and their standard deviations. Figure 1.3.1-1 shows the structure of the 2B-31 product in terms of the component objects and their sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications

SwathStructure (Attribute, 5000-byte character)
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following, Table 1.3.1-1.

Table 1.3.1-1
Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are high resolution pixel and scan. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180^0 meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number as shown in Table 1.3.1-2. All bytes in the Scan Status are copied from 1B-21 including the Missing byte. 2B-31 should reset the Missing byte if it determines data is missing or there is no-rain.

Table 1.3.1-2
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Missing	1-byte integer	Missing indicates whether information is contained in the scan data. This byte is copied from 1B-21 and possibly reset by 2B-31. The values are: 0 Scan data elements contain information 1 Scan was missing in the telemetry data 2 Scan data contains no elements with rain
Validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (other than 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)
QAC	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	1-byte integer	Geolocation Quality is broken into 8 bit flags. Each bit = 0 if the status is good but the bit = 1 if the status is bad. Each bit flag is listed below, arranged in approximate descending order of severity: Bit Meaning if bit = 1 0 Very bad geolocation results: Latitudes, longitudes, or other parameters out of bounds, or scan missed Earth (excluding CERES deep-sky calibration mode) 1 Lat/lon do not vary smoothly from scan to scan. Details **TBD**. Indicates problem with either current or previous scan, but cannot discriminate between them. 2 The difference between the roll/pitch/yaw in consecutive ACS packets was greater than **TBD** range. 3 Roll/pitch/yaw out of normal range. Range **TBD.** 4 Satellite undergoing maneuvers. (Geolocation is less accurate during maneuvers.) 5 Questionable Ephemeris or questionable UTCF, including use of predicted ephemeris for quicklook. 6 Geolocation calculations failed. Flags whether initialization failed, or whether geolocation processing failed, due to, e.g., error in allocating memory. 7 Geolocation quality control not be carried out (e.g., due to error

Name	Format	Description
		in initialization of QA parameters or failure to write QA verification intermediate product).

Table 1.3.1-2 (continued)
Scan Status
(Vdata Table, record size 15 bytes, nscan records)

Name	Format	Description
Data Quality	1-byte integer	The Quality of Data on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata.
Current Spacecraft Orientation	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
PR Mode	1-byte integer	Value Meaning 1 Observation Mode 2 Internal Calibration Mode 3 External Calibration Mode 4 Analysis Mode 5 Stand-by Mode
PR Status 1	1-byte integer	A description of PR sensor status such as FCIF Component used (A or B) and Initialization in Onboard Surface Search Algorithm. Details are **TBD** by NASDA.
PR Status 2	1-byte integer	See PR Status 1 description.
Fractional Orbit Number	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

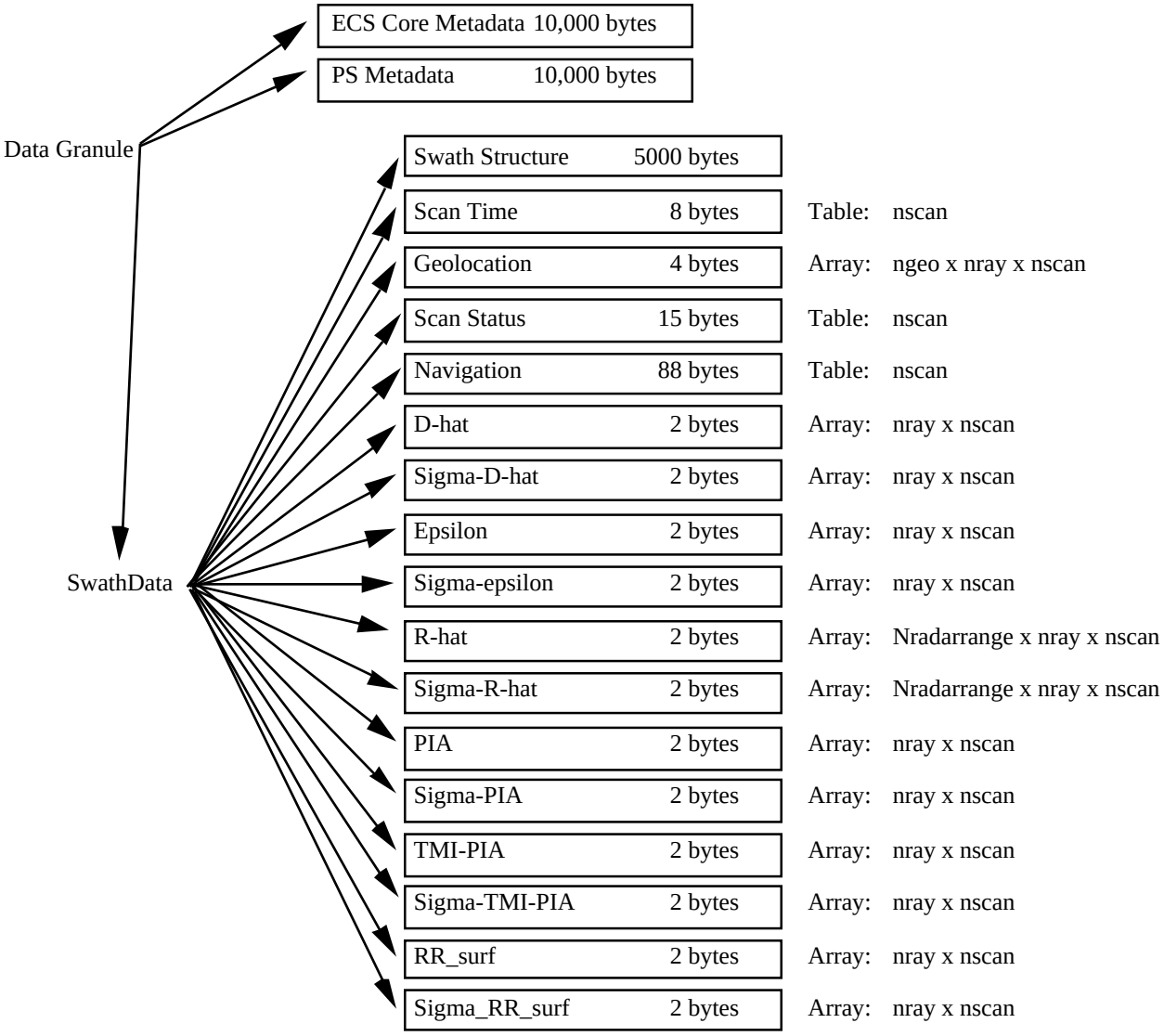


Figure 1.3.1-1
Data Format Structure for 2B-31, TRMM Combined

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix D in Volume 3 of ICS, Level 1 File Specifications

D-hat (SDS, array size nray x nscan, 2-byte integer):
The D-hat is the correlation-corrected mass-weighted mean drop diameter. It ranges from 0.50 to 2.50 "normalized"* mm and is multiplied by 100 and stored as a two-byte integer. The accuracy is 0.01 "normalized" mm.

Sigma-D-hat (SDS, array size nray x nscan, 2-byte integer):
The sigma-D-hat is the RMS uncertainty in the correlation-corrected mass-weighted mean drop diameter. It ranges from 0.00 to 2.00 "normalized"* mm and is multiplied by 100 and stored as an two-byte integer. The accuracy is 0.01 "normalized" mm.

Epsilon (SDS, array size nray x nscan, 2-byte integer):
The epsilon is the correction made to the input path-integrated attenuation estimate. It ranges from -50.0 to 50.0 dB and is multiplied by 10 and stored as a two-bye integer. The accuracy is 0.1 dB.

Sigma-epsilon (SDS, array size nray x nscan, 2-byte integer):
The sigma-epsilon is the RMS uncertainty in the correction made to the input path-integrated attenuation estimate. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1dB.

R-hat (SDS, array size Nradarrange x nray x nscan, 2-byte integer):
The R-hat is the instantaneous rain rate at the radar range gates. It ranges from 0.0 to 500.0 mm/hr and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 mm/hr.

Sigma-R-hat (SDS, array size Nradarrange x nray x nscan, 2-byte integer):
The sigma-R-hat is the RMS uncertainty in the instantaneous rain rate at the radar range gates. It ranges from 0.0 to 125.0 mm/hr and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.5 mm/hr

PIA (SDS, array size nray x nscan, 2-byte integer):
The PIA is the PR+TMI path-integrated attenuation estimate. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 dB.

Sigma-PIA (SDS, array size nray x nscan, 2-byte integer):
The sigma-PIA is the RMS uncertainty in the PR+TMI path-integrated attenuation estimate. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as an integer. The accuracy is 0.1 dB.

TMI-PIA (SDS, array size nray x nscan, 2-byte integer):
The TMI-PIA is the TMI estimate of the path-integrated attenuation. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 dB

Sigma-TMI-PIA (SDS, array size nray x nscan, 2-byte integer):
The sigma-TMI-PIA is the RMS uncertainty in the TMI estimate of path-integrated attenuation. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 dB.

RR-Surf (SDS, array size nray x nscan, 2-byte integer)
The RR-Surf is the surface rainrate. It ranges from 0.0 to 500.0 mm/hr and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 mm/hr.

Sigma-RR-Surf (SDS, array size nray x nscan, 2-byte integer)
The Sigma-RR-Surf is the RMS uncertainty in the surface rainrate. It ranges from 0.0 to 125.0 mm/hr and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.5mm/hr.

*"normalized units" are defined as follows:
If a variable X, expressed in grams, is correlated with the rain rate R and a variable Y is defined where $Y = X * R^{0.37}$ R, then the unit of Y is called “normalized grams”.

1.4 GV RADAR

There are four Level 2A products for GV radar, 2A-52 - Existence (Contact: Dr. Robert Houze), 2A-53 - Radar Site Rain Map (Contact: Dr. Robert Houze), 2A-54 Radar Site Convective/Stratiform Map (Contact: Dr. Robert Houze) and 2A-55 - Radar Site 3-D Reflectivities (Contact: Dr. Robert Houze). The formats of these products are based on the Version 1 algorithm descriptions and consultation with GV radar algorithm scientists. The granule size is one hour for 2A-53, 2A-54, and 2A-55 but one month for 2A-52. The following parameters are used in describing the formats:

- nvol: the number of volume scans within one granule (see Section 7 of Volume 3 of ICS for detailed explanation);
- nx_prod: the number of points in the x-dimension of a 3-D Cartesian grid; 151 for single radar sites; 363 for the multiple radar site in Texas and 257 for the Florida multiple radar site;
- ny_prod: the number of points in the y-dimension of a 3-D Cartesian grid; 151 for single radar sites; 285 for the multiple radar site in Texas and 353 for the Florida multiple radar site;
- nz: the number of points in the z-dimension of a 3-D Cartesian grid; 13 for both single and multiple radar sites;

- ncat: the number of categories for computing CFADs and vertical profiles. There are 12 categories (eg., stratiform precipitation, convective precipitation, water surface, and land, etc.) that are enumerated in each section where they apply;
- nbin: the maximum number of reflectivity bins; this is 86 which will allow a reflectivity range of -15dBZ to 70 dBZ with increments of 1 dBZ.

1.4.1 2A-52 - Existence

2A-52, "Existence", is the fraction of the radar FOV which has measurable precipitation. The GV radar FOV is defined as a base scan, i.e., the lowest level sweep. The output will be ASCII files instead of HDF files. In addition to the ASCII product file there will be a detached SFDU header. The SFDU header is described in the **Interface Control Document Between EOSDIS Core System (ECS) and TRMM Science Data and Information System (TSDIS) for the ECS Project**. Each product file has the Existence data of one site (not one radar) for one month. Figure 1.4.1-1 shows an example of 2A-52 output.

```
  Date of     Time of                Distance of      Date of     Time of
    VOS         VOS    %Rain  Hit Closest Approach(CA)   CA         CA
-------------------------------------------------------------------------
1998-01-28 00:00:00.000  34    1       634.528        1998-01-28 00:08:00.000
1998-01-28 00:10:00.000  46    0       -9999.9           NULL        NULL
```

Figure 1.4.1-1
Example of 2A-52, Existence.

The data is organized in seven columns separated by white space. All lines have 80 characters (including spaces). The first two lines of the file are the column descriptors. The third line is a dashed line. Data start at the fourth line. The data fields and the lengths are as follows:

Date of VOS
The Date of VOS is the date of the beginning of the VOS. It has format of YYYY-MM-DD, where YYYY=year, MM=month, DD=day, and "-" is literal.

Time of VOS
The Time of VOS is the time (UTC) of the beginning of the VOS. It has format of HH:MM:SS.sss, where HH=hour, MM=minute, SS=second, sss=millisecond, ":" and "." are literals.

%Rain
%Rain is the percent of the raining area in the radar FOV. It is an integer value with a range of 0 to 100.

Hit
The Hit field specifies which VOS was obtained when the satellite was the closest to the radar during coincidence. This will be a logical flag, 0(no hit) or 1(hit). There is a time limit of +/-30 minutes in seeking out the 'closest' volume scan (for example, for cases when the radar was down).

Distance of Closest Approach (CA)
Distance of Closest Approach (CA) is the distance (km) from the radar to the sub-satellite point when a "Hit" occurred. It is a floating point value with 3 decimal point precision and a range from 0.000 to 750.000. If there was no hit, -9999.9 will be used.

Date of CA
Date of CA (Date of Closest Approach) gives the date when the satellite is closest to the radar site. It has the same format as Date of VOS, while "NULL" will be used in the cases of "No Hit".

Time of CA
Time of CA (Time of Closest Approach) gives the time (UTC) when the satellite is closest to the radar. It has the same format as Time of VOS, while "NULL" will be used in the cases of "No Hit".

It should be noted that, in the case of a multiple radar site, %Rain is a combined result from all radars at that site, but Date of VOS, Time of VOS, Hit, Distance of Closest Approach, Date of CA and Time of CA apply to the primary radar only.

1.4.2 2A-53 - Radar Site Rain Map

2A-53, "Radar Site Rain Map", is an instantaneous surface rain rate map in Cartesian coordinates with a 2 km horizontal resolution. At single radar sites, the map covers an area of 300km x 300km. For the multiple radar site in Texas, the map covers a region of 724km x 568km, and in Florida 512km x 704km. Figure 1.4.2-1 shows the structure of the 2A-53 product in terms of the component objects and their sizes.

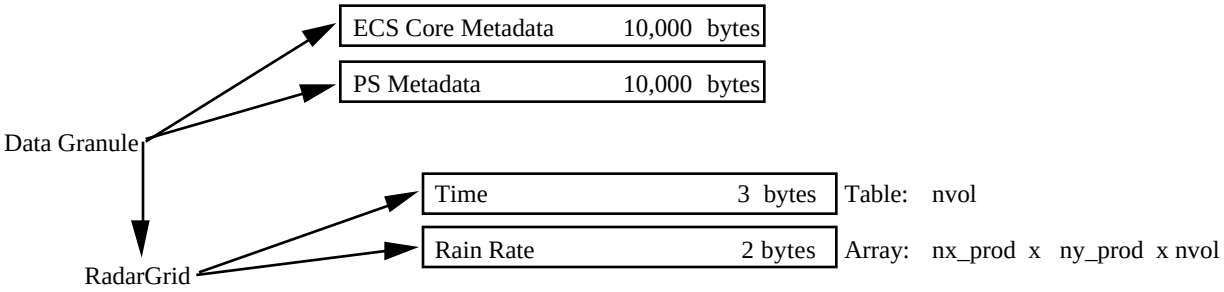


Figure 1.4.2-1
Data Format Structure for 2A-53, Radar Site Rain Map.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS.
See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS.

See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Time (Vdata Table, record size 3 bytes, nvol records):
The time is the UTC hour-of-day, minute-of-hour and second-of-minute for the start of each VOS in the granule. See the following, Table 1.4.2-1.

Table 1.4.2-1
Time

Name	Format	Description
Hour	1-byte integer	the UTC hour-of-day for the start of one volume scan.
Minute	1-byte integer	the UTC minute-of-hour for the start of one volume scan.
Second	1-byte integer	the UTC second-of-minute for the start of one volume scan.

Rain Rate (SDS, array size: nx_prod x ny_prod x nvol, 2-byte integer):
This is the rain rate at the base scan. The rain rate ranges from 0.0 to 1000.0 mm h^{-1}. It is multiplied by 10 and stored as a 2-byte integer.

1.4.3 2A-54 - Radar Site Convective/Stratiform Map

2A-54, "Radar Site Convective/Stratiform Map", is an instantaneous map in Cartesian coordinates with a 2 km resolution. At single radar sites, the map covers an area of 300km x 300km. For the multiple radar site in Texas, the map covers a region of 724km x 568km, and in Florida 512km x 704km. The map identifies the surface precipitation as convective or stratiform. Figure 1.4.3-1 shows the structure of the 2A-54 product in terms of the component objects and their sizes.

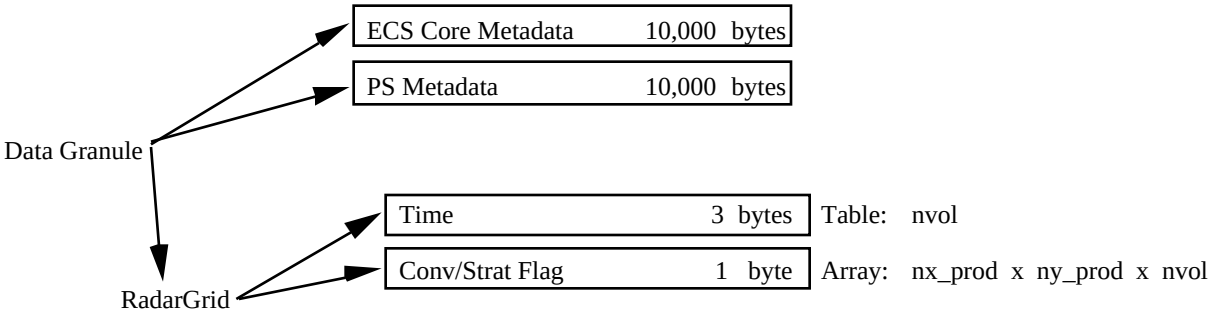


Figure 1.4.3-1
Data Format Structure for 2A-54, Radar Site Convective/Stratiform Map

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Time (Vdata Table, record size 3 bytes, nvol records):
The time is the UTC hour-of-day, minute-of-hour and second-of-minute for the start of each VOS in the granule. See the following Table 1.4.3-1.

Table 1.4.3-1
Time

Name	Format	Description
Hour	1-byte integer	the UTC hour-of-day for the start of one volume scan.
Minute	1-byte integer	the UTC minute-of-hour for the start of one volume scan.
Second	1-byte integer	the UTC second-of-minute for the start of one volume scan.

Conv/Strat Flag (SDS, array size: nx_prod x ny_prod x nvol, 1-byte integer):
The Convective/Stratiform flag is an instantaneous map in Cartesian coordinates. Each value represents the rain type of the entire vertical column. The following values are assigned for the Convective/Stratiform Flag:

0: no echo;

1: stratiform;

2: convective.

-99: missing data

1.4.4 2A-55 - Radar Site 3-D Reflectivities

2A-55, “Radar Site 3-D Reflectivities”, is composed of 3 different fields. The first field has an array of 3-D reflectivities in Cartesian coordinates with a 2 km horizontal resolution over an area of 300km x 300km for single radar sites, and 724km x 568km for Texas multiple radar site, 512km x 704 km for Florida multiple radar site. It has a vertical resolution of 1.5km and a height range up to 19.5 km. The second field has an array of vertical profiles based on the first field, and the third field has an array of the Contoured Frequency by Altitude Diagram (CFAD) data based on the first and second field. Figure 1.4.4-1 shows the structure of the 2A-55 product in terms of the component objects and their sizes.

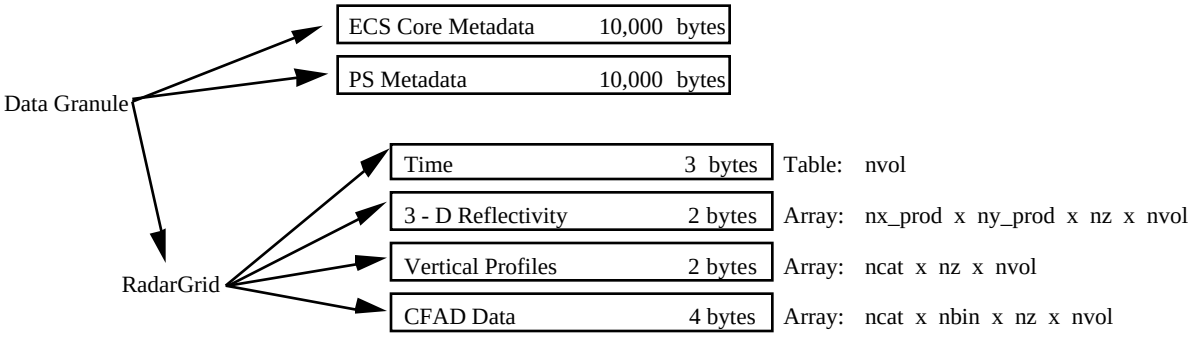


Figure 1.4.4-1
Data Format Structure for 2A-55, Radar Site 3-D Reflectivity

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Time (Vdata Table, record size 3 bytes, nvol records):
The time is the UTC hour-of-day, minute-of-hour and second-of-minute for the start of each VOS in the granule. See the following, Table 1.4.4-1.

Table 1.4.4-1
Time

Name	Format	Description
Hour	1-byte integer	the UTC hour-of-day for the start of one volume scan.
Minute	1-byte integer	the UTC minute-of-hour for the start of one volume scan.
Second	1-byte integer	the UTC second-of-minute for the start of one volume scan.

3-D Reflectivity (SDS, array size nx_prod x ny_prod x nz x nvol , 2-byte integer):
The 3-D Reflectivity is the instantaneous reflectivity interpolated from volume scans onto a 3-D Cartesian coordinate system with a 1.5km vertical resolution to a height of 19.5km, and a 2 km horizontal resolution with varied covering ranges from single radar sites to multiple radar sites. For single radar sites, the horizontal area is 300km x 300km. At the multiple radar site in Texas, the area is 724km x 568km while in Florida it is 512km x 704km. Values range from -15.00 to 70.00 dBZ and are multiplied by 100 and stored as a 2-byte integer.

Vertical Profiles (SDS, array size ncat x nz x nvol , 2-byte integer):
The vertical profiles include reflectivities at each of the nz analysis levels for the following categories:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) anvil (Anvil is defined as echo aloft with no contribution to surface rain.);
11) anvil over land;
12) anvil over sea.

Values range from -15.00 to 70.00 dBZ and are multiplied by 100 and stored as a 2-byte integer.

CFAD Data (SDS, array size ncat x nbin x nz x nvol , 4-byte integer):
The CFAD Data are the numbers of pixels counted in specified height-reflectivity bin pairs for the 12 categories listed below for each volume of radar data. nbin is the number of reflectivity bins and ranges from -15dBZ to 70dBZ. Values range from 0 to 22,801 (151 x 151) for single radar sites while from 0 to 103,455 (363 x 285) for Texas multiple radar site, and 0 to 90,721 (257 x 353) for Florida multiple radar site. The 12 categories are:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) anvil (Anvil is defined as echo aloft with no contribution to surface rain.);
11) anvil over land;
12) anvil over sea.

1.5 RAIN GAUGE AND DISDROMETER

There is one level 2A data product each for rain gauge data and disdrometer data. These products are 2A-56 - Rain Gauge and 2A-57 - Disdrometer, respectively. The formats of these products are based on the Version 1 algorithm descriptions and consultation with algorithm scientists. The granule size is 1 day. The following parameters are used to describe the formats:

- mtime: the maximum number of measurements at one rain gauge within one granule (1440, once per minute).
- ngauge: the number of rain gauges at a GV site (about 30 for single radar sites and 120 for multiple radar sites, has large variability)
- ndis: the number of disdrometers at each GV site (typically 1 for single radar sites and 4 for multiple radar sites, but the number could be larger or smaller).
- nclass: the number of size classes (20).
- nnet: the number of networks at a radar site (typically 1 or 2 but larger for multiple radar sites)

1.5.1 2A-56 - Rain Gauge

There are rain gauges (about 30 according to TRMM Science Requirements) for each GV radar. The product, 2A-56 - "Rain Gauge", converts the tipping-bucket or optical gauge data to a standard product consisting of one minute rain rates. Figure 1.5.1-1 shows the structure of the 2A-56 product in terms of the component objects and their sizes.

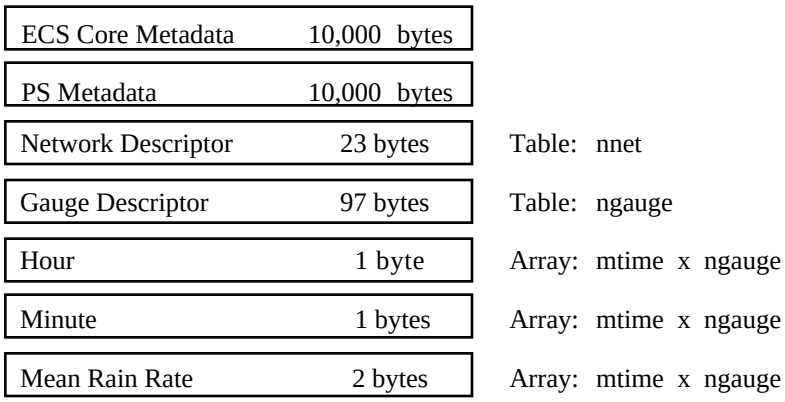


Figure 1.5.1-1
Data Format Structure for 2A-56, Rain Gauge

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Network Descriptor (Vdata Table, record size 23 bytes, nnet records):
This describes the network which contains the gauges. Since there may be multiple networks at a site the Network ID is used to associate a particular gauge with a given network. See the following Table 1.5.1-1, for a description of all entries.

Table 1.5.1-1
Network Descriptor

Name	Format	Description
Network Name	20-byte character	Name of this gauge Network
Number of Validation Sensors	2-byte integer	The number of gauges in this network.
Network ID	1-byte integer	Number of the network in this granule (1,2,3,4....)

Gauge Descriptor (Vdata Table, record size 97 bytes, ngauge records):
A rain gauge descriptor contains the information which is unique for each rain gauge, such as name, model number, latitude, longitude, etc. Note the Network ID associates a particular gauge with a network in the Network Descriptor. See the following, Table 1.5.1-2.

Table 1.5.1-2

Gauge Descriptor

Name	Format	Description
Network ID	1-byte integer	The number of the network to which this gauge belongs.
Gauge Type	20-byte character	Type of rain gauge e.g. tipping bucket, optical, etc.
Gauge Name	20-byte character	Name of rain gauge
Gauge Make/Model	20-byte character	Make and model of gauge
Gauge Number	4-byte integer	Identification number of rain gauge
Gauge Latitude	4-byte float	Rain gauge latitude. Positive north, negative south.
Gauge Longitude	4-byte float	Rain gauge longitude. Positive east, negative west.
Range	4-byte float	Distance (km) from radar
Azimuth	4-byte float	Azimuth of gauge, relative to radar and true north
X_Coordinate	4-byte float	X coordinate of gauge on a Cartesian grid with a 2 km horizontal resolution and radar at (0,0)
Y_Coordinate	4-byte float	Y coordinate of gauge on a Cartesian grid with a 2 km horizontal resolution and radar at (0,0)
Resolution	4-byte float	Minutes
Elevation	4-byte float	Meters (MSL)

Hour (SDS, array size mtime x ngauge, 1-byte integer):
The Hour is the UTC hour-of-day for the start of one measurement.

Minute (SDS, array size mtime x ngauge, 1-byte integer):
The Minute is the UTC minute-of-hour for the start of one measurement.

Mean Rain Rate (SDS, array size mtime x ngauge, 2-byte integer):
The Mean Rain Rate is the rain rate averaged over one minute for one rain gauge. It ranges from 0.0 to 1000.0 mm h^{-1} and is multiplied by 10 and stored as a 2-byte integer.

1.5.2 2A-57 - Disdrometer

There are disdrometers at some radar sites.. The product, 2A-57, “Disdrometer”, produces the observations of the rain drop number concentration in each of 20 size class intervals. Figure 1.5.2-1 shows the structure of 2A-57 product in terms of the component objects and their sizes.

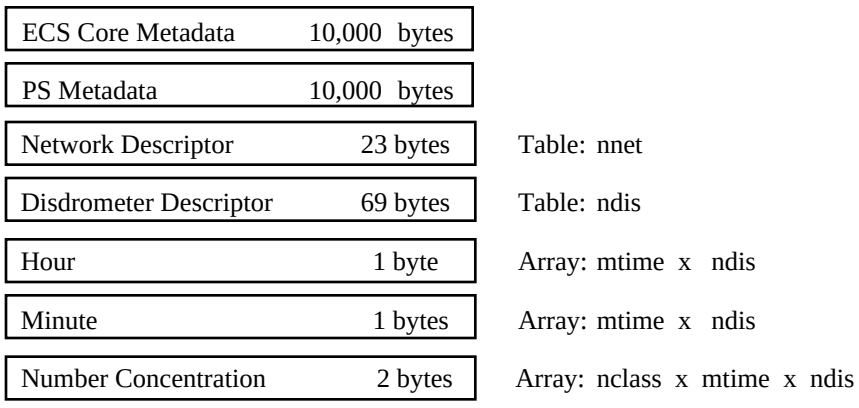


Figure 1.5.2-1
Data Format Structure for 2A-57, Disdrometer

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS.
See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS.
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Network Descriptor (Vdata Table, record size 23 bytes, nnet records):
This describes the network which contains the disdrometers. Since there may be multiple networks at a site the Network ID is used to associate a particular disdrometer with a given network. See the following Table 1.5.2-1, for a description of all entries.

Table 1.5.2-1
Network Descriptor

Name	Format	Description
Network Name	20-byte character	Name of this Network
Number of Validation Sensors	2-byte integer	The number of disdrometers in this network
Network ID	1-byte integer	Number of the network in this granule (1,2,3,4....)

Disdrometer Descriptor (Vdata Table, record size 69 bytes, ndis records):
A rain disdrometer descriptor is a defined block which contains the information which is unique for the rain disdrometer, such as name, model number, latitude, longitude, etc. Note the Network ID associates a particular disdrometer with a network in the Network Descriptor. See the following, Table 1.5.2-2.

Table 1.5.2-2
Disdrometer Descriptor

Name	Format	Description
Network ID	1-byte integer	Number of the network to which this disdrometer belongs
Disdrometer Name	20-byte character	Name of rain disdrometer
Disdrometer Make/Model	20-byte character	Make and model of disdrometer
Disdrometer Number	4-byte integer	Identification number of rain disdrometer
Disdrometer Latitude	4-byte float	Rain disdrometer latitude. Positive north,negative south
Disdrometer Longitude	4-byte float	Rain disdrometer longitude. Positive east, negative west
Range	4-byte float	Distance (km) from radar
Azimuth	4-byte float	Azimuth of disdrometer, relative to radar and true north
Resolution	4-byte float	Minutes
Elevation	4-byte float	Meters (MSL)

Hour (SDS, array size mtime x ndis, 1-byte integer):
The Hour is the UTC hour-of-day for the start of one measurement.

Minute (SDS, array size mtime x ndis, 1-byte integer):
The Minute is the UTC minute-of-hour for the start of one measurement.

Number Concentration (SDS, array size nclass x mtime x ndis, 2-byte integer):
This is the rain drop number concentration in each of 20 size class intervals in one minute for one disdrometer.

2. LEVEL 3 PRODUCTS

Level 3 data products are either 5-day or monthly products calculated from Level 1 and Level 2 data. TSDIS will produce 9 Level 3 products from satellite data and ground validation data. Satellite data include TMI, VIRS, PR data from TRMM satellite, the SSM/I data from Defense Meteorological Satellite Program (DMSP) polar orbiting satellites, infrared data from the Geostationary Operational Environmental Satellite (GOES) which are available from Global Precipitation Climatology Project (GPCP) and the global rain gauge data from both the Global Precipitation Climatology Center (GPCC) and the Climate Assessment and Monitoring System (CAMS). Only GV radar data are included as input data for Level 3 GV products.

2.1 TRMM MICROWAVE IMAGER (TMI)

There is one level 3A data product for TMI, 3A-11 ¾ TMI Emission (PI: Dr. Alfred Chang). The format of this product is designed in consultation with TMI algorithm scientists. The granule size is one month. The following parameters are used in describing the formats:

- nlat: the number of 5° grid intervals of latitude from 40° N to 40° S (16).
- nlon: the number of 5° grid intervals of longitude (72).

2.1.1 3A-11 - TMI Emission

3A-11, "TMI Emission", produces 5° x 5° monthly oceanic rainfall maps using TMI Level-1 data. Statistics of the monthly rainfall will also be calculated. Figure 2.1.1-1 shows the structure of the 3A-11 product in terms of the component objects and sizes.

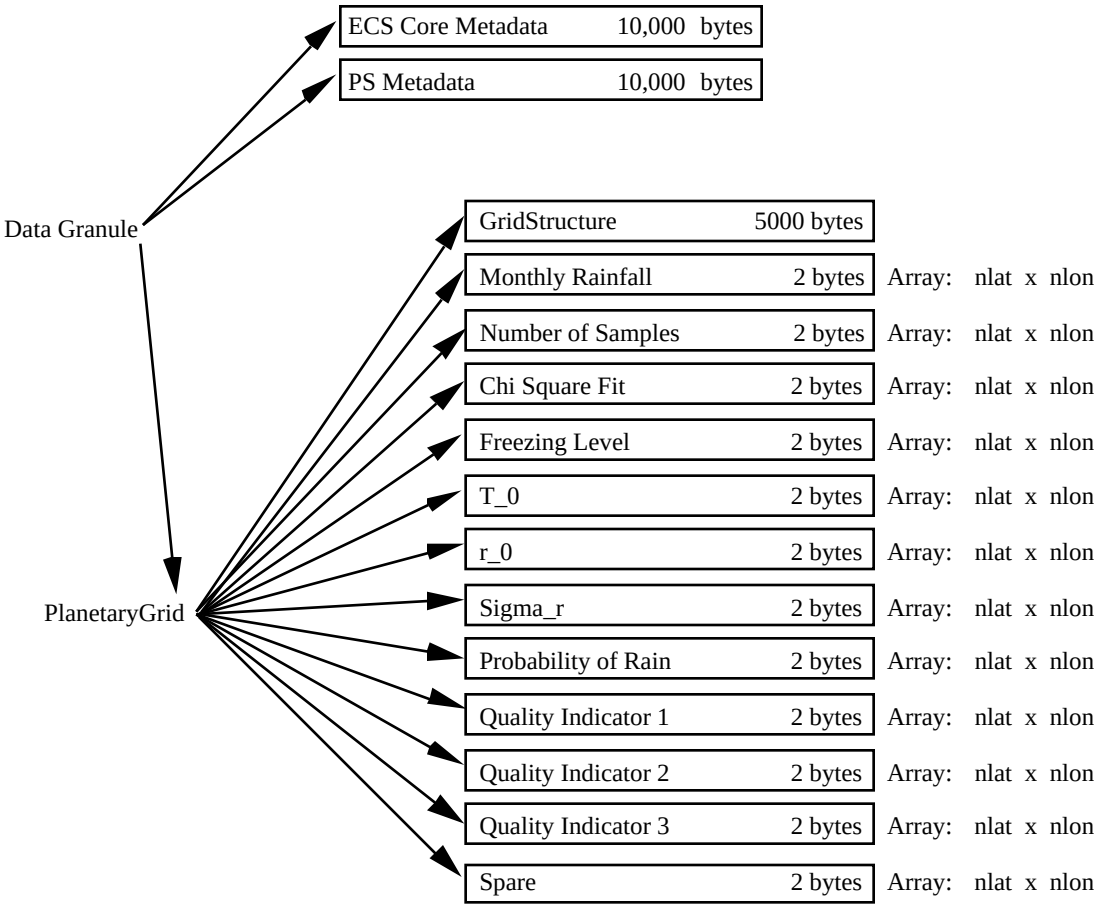


Figure 2.1.1-1
Data Format Structure for 3A-11, TMI Emission

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Monthly Rainfall (SDS, array size nlat x nlon, 2-byte integer):

The Monthly Rainfall is the surface rainfall over oceans in 5° x 5° boxes from 40°N to 40°S. It ranges from 0.0 to 3000.0 mm and is multiplied by 10 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Number of Samples (SDS, array size nlat x nlon, 2-byte integer):

The Number of Samples is that over oceans in 5° x 5° boxes for one month. Ranges are **TBD**. Data on land areas are assigned the value -9999.

Chi Square Fit (SDS, array size nlat x nlon, 2-byte integer):
The Chi Square Fit indicates how well the histogram of brightness temperatures fits the lognormal distribution function in 5° x 5° boxes for one month. It ranges from 1 to 5000. Data on land areas are assigned the value -9999.

Freezing Level (SDS, array size nlat x nlon, 2-byte integer):

The Freezing Level is the estimated height of 0^0C isotherm over oceans in 5° x 5° boxes for one month. It ranges from 0.00 to 6.00 km and is multiplied by 100 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

T_0 (SDS, array size nlat x nlon, 2-byte integer):

The T_0 is the mean of non-raining brightness temperatures over oceans in 5° x 5° boxes for one month. It ranges from 160.0 to 180.0 K and is multiplied by 10 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

r_0 (SDS, array size nlat x nlon, 2-byte integer):

The r_0 is the logarithmic mean rain rate over oceans in 5° x 5° boxes for one month. It ranges from 0.00 to 15.00 mm h^{-1} and is multiplied by 100 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Sigma_r (SDS, array size nlat x nlon, 2-byte integer):

The Sigma_r(σ_r) is the standard deviation of logarithmic rain rates over oceans in 5° x 5° boxes for one month. It ranges from 0.00 to 1.00 mm h^{-1} and is multiplied by 100 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Probability of Rain (SDS, array size nlat x nlon, 2-byte integer):

The Probability of Rain is that over oceans in 5° x 5° boxes for one month. It ranges from 0.000 to 1.000 and is multiplied by 1000 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Quality Indicator 1 (SDS, array size nlat x nlon, 2-byte integer):
TBD

Quality Indicator 2 (SDS, array size nlat x nlon, 2-byte integer):
TBD

Quality Indicator 3 (SDS, array size nlat x nlon, 2-byte integer):
TBD

Spare (SDS, array size nlat x nlon, 2-byte integer):
TBD.

2.2 PRECIPITATION RADAR (PR)

There are two Level 3A products for the PR, 3A-25 - PR Rainfall (PI: Dr. Robert Meneghini), and 3A-26 - Surface Rain (PI: Dr. Robert Meneghini). The formats of these products are based on Version 2.2 algorithm descriptions given by PR algorithm scientist. The granule size is one month. The following parameters are used in describing the formats:

- nlat: the number of 5° grid intervals of latitude from 40° N to 40° S (16).
- nlon: the number of 5° grid intervals of longitude (72).
- nlath: the number of 0.5° grid intervals of latitude from 37° N to 37° S (148).
- nlonh: the number of 0.5° grid intervals of longitude (720).
- nh1: the number of fixed heights, at 2, 4, 6, 10 and 15 km plus one for path-average (6).
- nh2: the number of fixed heights, at 2, 4, and 6 km (3).
- ncat1: the first number of categories for reflectivity and rain rate histograms (25).
  The categories are **TBD**.
- ncat2: the second number of categories for histograms (30).
  This applies to histograms other then reflectivity and rainfall rate. Thresholds are given below for several variables, others are **TBD.**
  Bright Band and Snow Layer Depth (km):
  0.01, 0.25, 0.5, 0.75, 1., 1.25, 1.5, 1.75, 2., 2.25, 2.5, 2.75, 3., 3.25, 3.5,
  3.75, 4., 4.25, 4.5, 4.75, 5.25, 5.5, 5.75, 6., 6.25, 6.5, 6.75, 7., 7.5, 20.
  All Storm Heights (km):
  0.01, 0.5, 1., 1.5, 2., 2.5, 3., 3.5, 4., 4.5, 5., 5.5, 6., 6.5, 7., 7.5, 8., 8.5, 9.,
  9.5, 10., 10.5, 11., 11.5, 12., 12.5, 13., 14., 15., 16., 20.
  ZPZM (km):
  0., 1., 2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12., 13., 14., 15., 16., 17., 18., 19.,
  20., 22., 24., 26., 28., 30., 32., 34., 36., 38., 50.
  All PIA (dB):
  0., 1., 2., 3., 4., 5., 6., 7., 8., 9., 10., 12., 14., 16., 18., 20., 22., 24., 26., 28.,
  30., 32., 34., 36., 38., 40., 45., 50., 55., 60., 100.
- nang: the number of fixed incidence angles, at 0^0, 5^0, 10^0 and 15^0 (4).
- nh3: the number of fixed heights, at 2, 4, and 6 km plus one for path-average (4).

- npa: the number of parameters of fitting function (3).
- nop: the maximum number of overpasses for a 5° x 5° latitude/longitude box and one month (110).
- nth: the number of selected thresholds (10).
- nthrsh: the number of thresholds used for probability distribution functions (6). Values are **TBD**.

2.2.1 3A-25 - PR Rainfall

3A-25, "PR Rainfall", computes monthly statistics of the PR measurements at both a low horizontal resolution (5^0 x 5^0 latitude/longitude) and a high horizontal resolution (0.5^o x 0.5^o latitude/longitude). The low resolution grids are in the Planetary Grid 1 structure and include 1) mean and standard deviation of the rain rate, reflectivity, path-integrated attenuation (PIA), storm height, Xi, bright band height and the NUBF (Non-Uniform Beam Filling) correction; 2) rain fractions; 3) histograms of the storm height, bright-band height, snow-ice layer, reflectivity, rain rate, path-attenuation and NUBF correction; 4) correlation coefficients. For the high resolution grids in the Planetary Grid 2 structure, mean rain rate along with standard deviation and rain fractions are computed. Figure 2.2.1-1 shows the structure of the 3A-25 product in terms of the component objects and their sizes. The Vgroups of PlanetaryGrid 1 and PlanetaryGrid 2 are Planetary Grid structure.

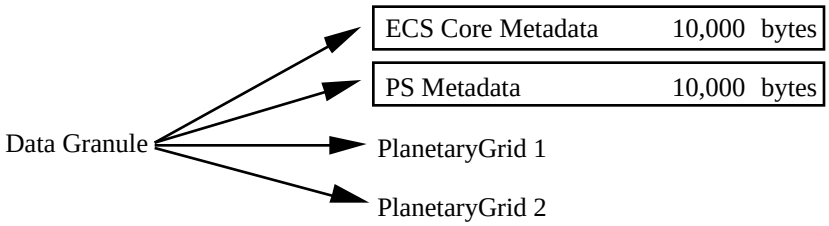
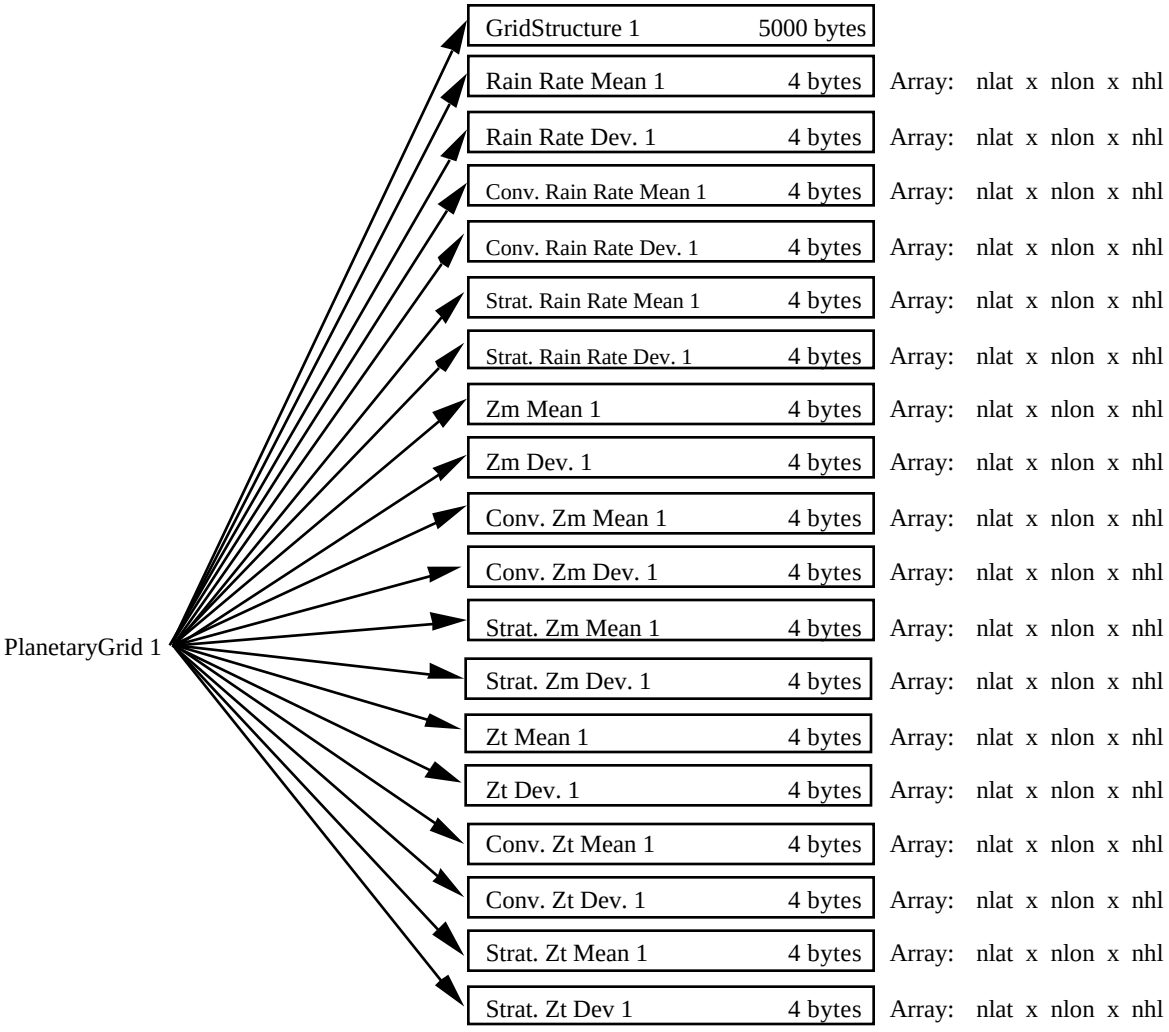
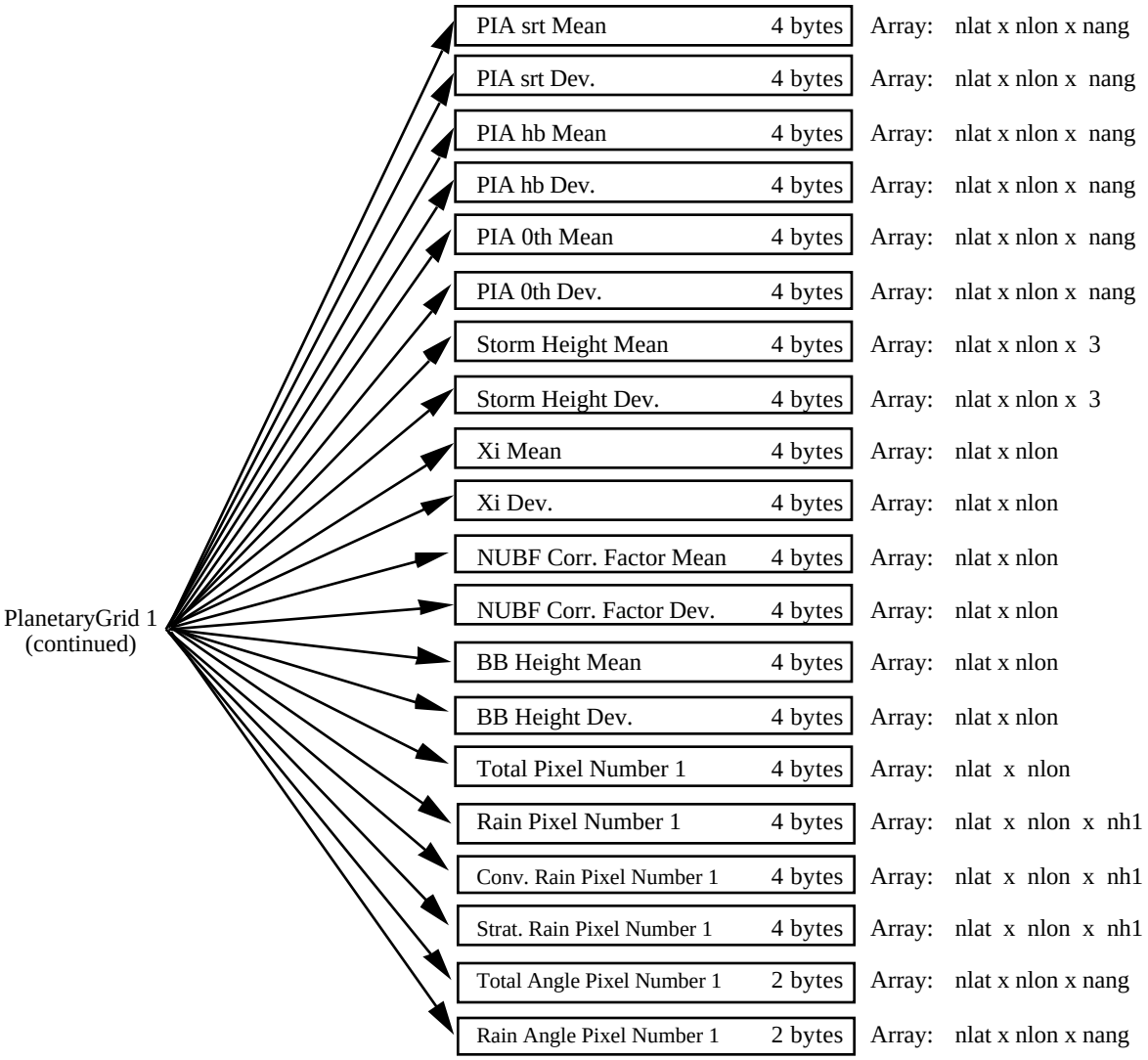


Figure 2.2.1-1
Data Format Structure for 3A-25, PR Rainfall



Continued on next page

Figure 2.2.1-1 (continued)
Data Format Structure for 3A-25, PR Rainfall



Continued on next page

Figure 2.2.1-1 (continued)
Data Format Structure for 3A-25, PR Rainfall

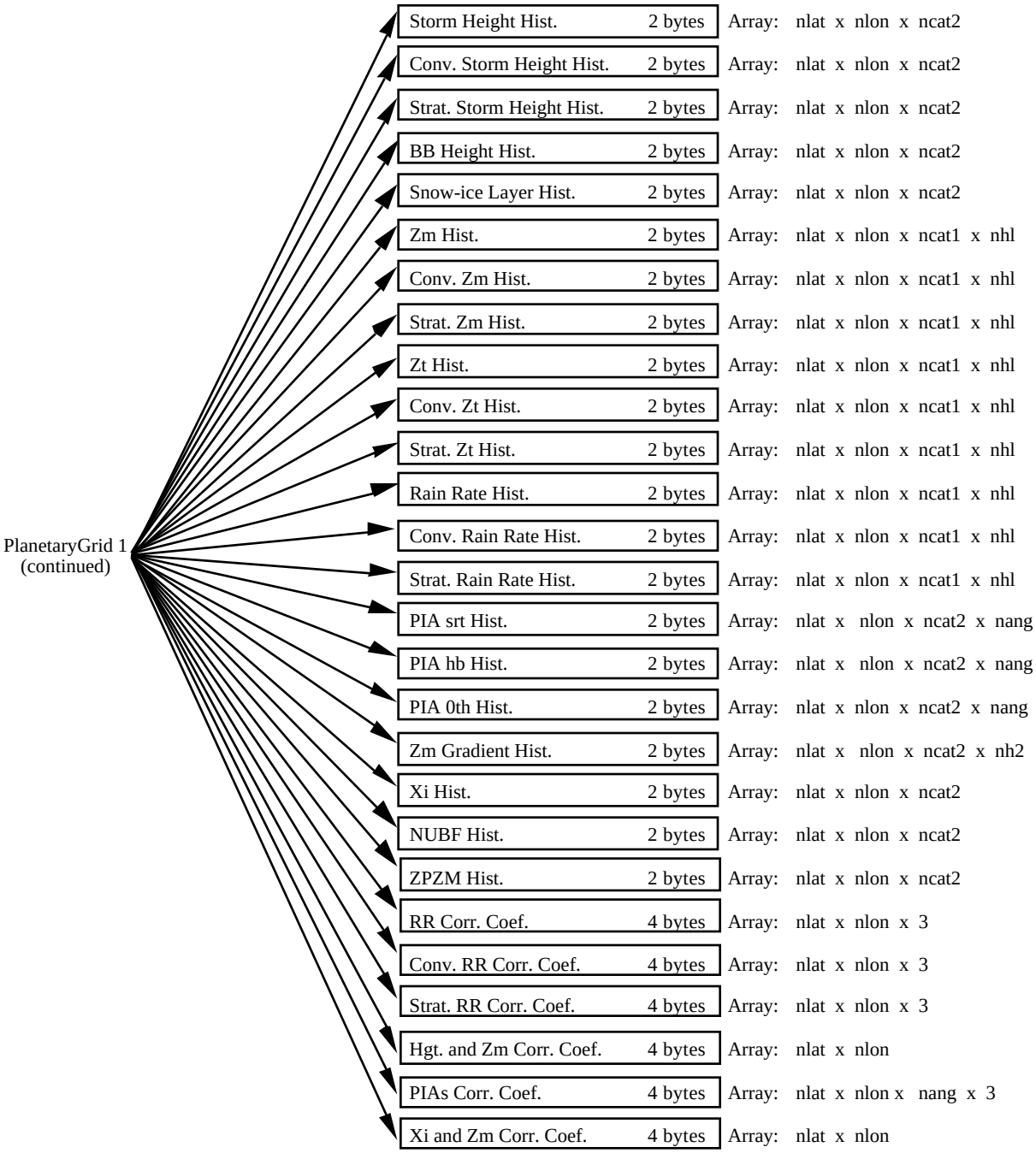


Figure 2.2.1-1 (continued)
Data Format Structure for 3A-25, PR Rainfall

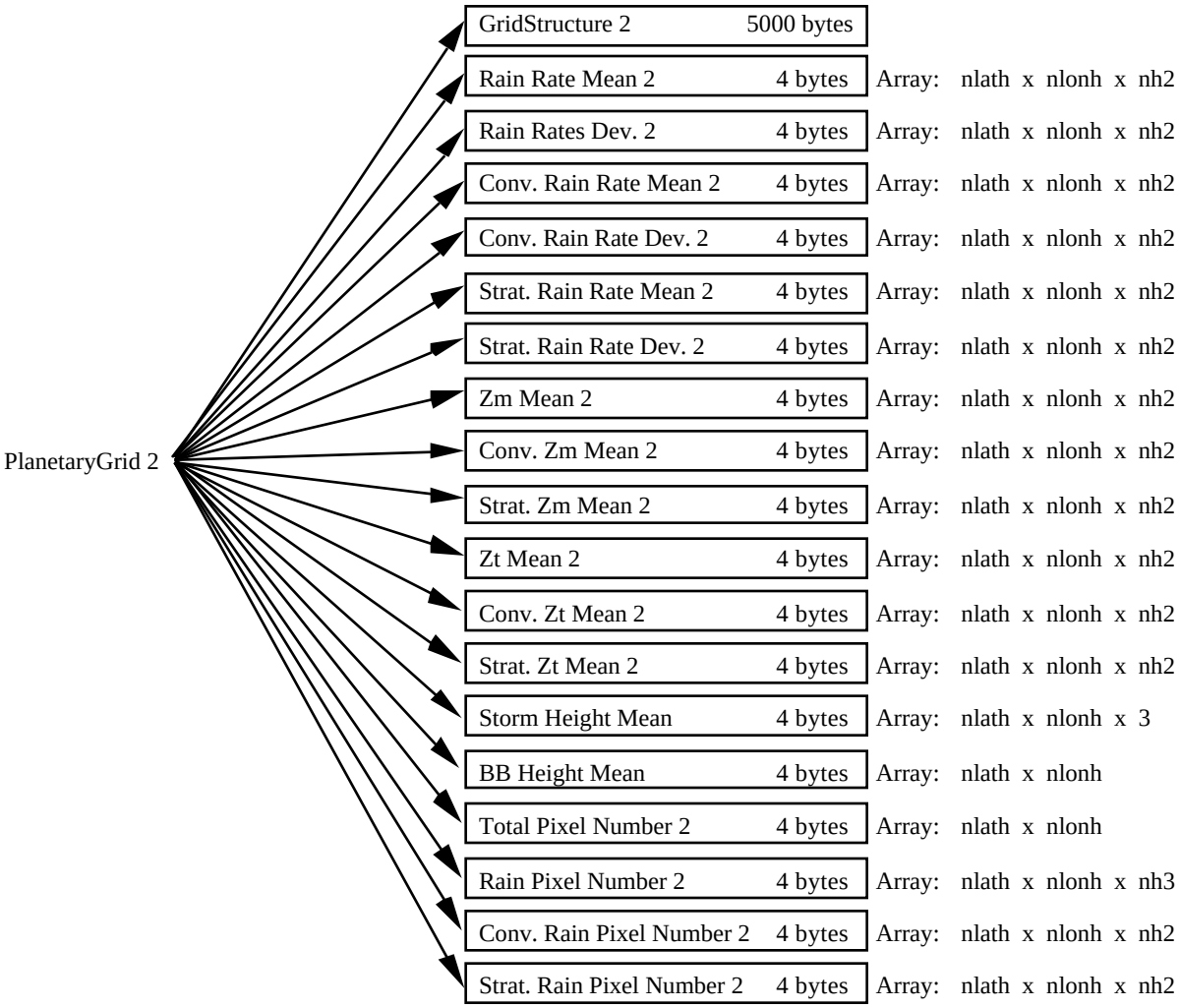


Figure 2.2.1-1 (continued)
Data Format Structure for 3A-25, PR Rainfall

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

GridStructure 1 (Attribute, 5000-byte character):
GridStructure 1 gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Rain Rate Mean 1 gives means of nonzero rain rates over 5^0 x 5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated for the path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
These are standard deviations of nonzero rain rates over 5^0 x 5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Conv. Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Rain Rate Mean 1 gives means of nonzero rain rates for convective rain over 5^0 x 5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Conv. Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Rain Rates Dev. 1 gives standard deviations of nonzero rain rates for convective rain over 5^0 x 5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Strat. Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Rain Rate Mean 1 gives means of nonzero rain rates for stratiform rain over 5^0 x 5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Strat. Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Rain Rates Dev. 1 gives standard deviations of nonzero rain rates for stratiform rain over 5^0 x 5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Zm Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zm Mean 1 gives means of measured radar reflectivity at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month using data from 1C-21. It ranges from -20 to 80 dBZ.

Zm Dev.1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zm Dev. 1 gives standard deviations of measured radar reflectivity at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month using data from 1C-21. It ranges from 0 to 100 dBZ.

Conv. Zm Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Conv. Zm Mean 1 gives the monthly means of measured radar reflectivity for convective rain at a horizontal resolution of 5^0 x 5^0. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from -20 to 80 dBZ.

Conv. Zm Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Conv. Zm Dev. 1 gives the monthly standard deviations of measured radar reflectivity for convective rain at a horizontal resolution of 5^0 x 5^0. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from 0 to 100 dBZ.

Strat. Zm Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Strat. Zm Mean 1 gives the monthly means of measured radar reflectivity for stratiform rain at a horizontal resolution of 5^0 x 5^0. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from -20 to 80 dBZ.

Strat. Zm Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Strat. Zm Dev. 1 gives the monthly standard deviations of measured radar reflectivity for stratiform rain at a horizontal resolution of 5^0 x 5^0. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from 0 to 100 dBZ.

Zt Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zt Mean 1 gives means of corrected radar reflectivity factors at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month using data from 2A-25. It ranges from 0.1 to 80 dBZ.

Zt Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zt Dev. 1 gives standard deviations of corrected radar reflectivity factors at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month using data from 2A-25. It ranges from 0.0 to 80 dBZ.

Conv. Zt Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Conv. Zt Mean 1 gives the monthly means of corrected radar reflectivity for convective rain at a horizontal resolution of 5^0 x 5^0. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.1 to 80 dBZ.

Conv. Zt Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Conv. Zt Dev. 1 gives the monthly standard deviations of corrected radar reflectivity for convective rain at a horizontal resolution of 5^0 x 5^0. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.0 to 80 dBZ.

Strat. Zt Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Strat. Zt Mean 1 gives the monthly means of measured radar reflectivity for stratiform rain at a horizontal resolution of 5^0 x 5^0. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.1 to 80 dBZ.

Strat. Zt Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float)
Strat. Zt Dev. 1 gives the monthly standard deviations of corrected radar reflectivity for stratiform rain at a horizontal resolution of 5^0 x 5^0. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.0 to 80.0 dBZ.

PIA srt Mean (SDS, array size nlat x nlon x nang, 4-byte float)
PIA srt Mean gives the monthly means of SRT (surface reference technique) path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5^0 x 5^0. It has units of dB and a range from -100 dB to 100 dB.

PIA srt Dev. (SDS, array size nlat x nlon x nang, 4-byte float)
PIA srt Dev. gives the monthly standard deviation of SRT path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5^0 x 5^0. It has units of dB and a range from -100 dB to 100 dB.

PIA hb Mean (SDS, array size nlat x nlon x nang, 4-byte float)
PIA hb Mean gives the monthly means of HB path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5^0 x 5^0. It has units of dB and a range from -100 dB to 100 dB.

PIA hb Dev. (SDS, array size nlat x nlon x nang, 4-byte float)
PIA hb Dev. gives the monthly standard deviation of HB path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5^0 x 5^0. It has units of and a range from -100 dB to 100 dB.

PIA 0th Mean (SDS, array size nlat x nlon x nang, 4-byte float)
PIA 0th Mean gives the monthly means of the 0th-order path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5^0 x 5^0. It has units of and a range from -100 dB to 100 dB.

PIA 0th Dev. (SDS, array size nlat x nlon x nang, 4-byte float)
PIA 0th Dev. gives the monthly standard deviation of the 0th-order path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5^0 x 5^0. It has units of dB and a range from -100 dB to 100 dB.

Storm Height Mean (SDS, array size nlat x nlon x 3, 4-byte float)
Storm Height Mean is the mean of the storm height for conditions of stratiform rain, convective rain and unconditional rain. It has units of meters and ranges from 0.0 to 20,000.

Storm Height Dev. (SDS, array size nlat x nlon x 3, 4-byte float)
Storm Height Dev. is the standard deviation of the storm height for conditions of stratiform rain, convective rain and unconditional rain. It has units of meters and ranges from 0.0 to 20,000.

Xi Mean (SDS, array size nlat x nlon, 4-byte float)
Xi Mean gives the monthly means of the horizontal non-uniformity parameter of the rain field within a ray at a horizontal resolution of 5^0 x 5^0. It has no units and ranges from 0.0 to **TBD.**

Xi Dev. (SDS, array size nlat x nlon, 4-byte float)
Xi Dev. gives the monthly standard deviation of the horizontal non-uniformity parameter of the rain field within a ray at a horizontal resolution of 5^0 x 5^0. It has no units and ranges from 0.0 to **TBD.**

NUBF Correction Factor Mean (SDS, array size nlat x nlon, 4-byte float)
The NUBF (Non-Uniform Beam Filling) Correction Factor Mean gives the monthly mean of NUBF correction for Z-factor and Rain Rate at a horizontal resolution of 5^0 x 5^0. It has no units and a range of 0 to 2.0.

NUBF Correction Factor Dev. (SDS, array size nlat x nlon, 4-byte float)
The NUBF (Non-Uniform Beam Filling) Correction Factor Dev. gives the monthly standard deviation of the NUBF correction for Z-factor and Rain Rate at a horizontal resolution of 5^0 x 5^0. It has no units and ranges from 0 to 2.0.

BB Height Mean (SDS, array size nlat x nlon, 4-byte float)
BB Height Mean gives the monthly means of the bright band height at a horizontal resolution of 5^0 x 5^0. It has units of meters and ranges from 0 to 20,000.

BB Height Dev. (SDS, array size nlat x nlon, 4-byte float)
BB Height Dev. gives the monthly deviation of the bright band height at a horizontal resolution of 5^0 x 5^0. It has units of meters and ranges from 0 to 20,000.

Total Pixel Number 1 (SDS, array size nlat x nlon, 4-byte integer):
The Total Pixel Number 1 is the number of total pixels over 5^0 x 5^0 boxes for one month. The range is 0 to 2,000,000.

Rain Pixel Number 1 (SDS, array size nlat x nlon x nh1, 4-byte integer):
The Rain Pixel Number 1 is the number of nonzero rain rate pixels at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month. The range is 0 to 2,000,000.

Conv. Rain Pixel Number 1(SDS, array size nlat x nlon x nh1, 4-byte integer):
The Convective Rain Pixel Number 1 is the number of nonzero rain rate pixels for convective rain at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month. The range is 0 to 2,000,000.

Strat. Rain Pixel Number 1 (SDS, array size nlat x nlon x nh1, 4-byte integer):
The Stratiform Rain Pixel Number 1 is the number of nonzero rain rate pixels for stratiform rain at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5^0 x 5^0 boxes for one month. The range is 0 to 2,000,000.

Total Angle Pixel Number 1 (SDS, array size nlat x nlon x nang, 2-byte integer)
Total Angle Pixel Number 1 is the total number of pixels over each 5^0 x 5^0 latitude-longitude grid box for a month. This parameter is accumulated at four different angles, i.e., 0^o, 5^o, 10^o and 15^o. The range is 0 to 30,000.

Rain Angle Pixel Number 1 (SDS, array size nlat x nlon x nang, 2-byte integer)
Rain Angle Pixel Number 1 is the total number of non-zero rain rate pixels over each 5^0 x 5^0 latitude-longitude grid box for a month. This parameter is accumulated at four different angles, i.e., 0^o, 5^o, 10^o, and 15^o. The range is 0 to 30,000.

Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the 'effective' storm heights for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the 'effective' storm heights for convective rain for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Strat. Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the 'effective' storm heights for stratiform rain for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

BB Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the bright-band heights for 30 categories over a 5° x 5° box for one month, given that the bright band is detected. It ranges from 0 to 32,767.

Snow-ice Layer Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the depth of snow-ice layer for 30 categories over a 5° x 5° box for one month. The depth of snow-ice layer is defined as the difference between effective storm height and estimated height of 0°C isotherm. It ranges from 0 to 32,767.

Zm Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
The Zm Histograms are histograms of measured reflectivities of rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Zm Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
The Convective Zm Histograms are histograms of measured reflectivities of convective rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Strat. Zm Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
The Stratiform Zm Histograms are histograms of measured reflectivities of stratiform rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Zt Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
The Zt Histograms are histograms of corrected reflectivity factors for rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Zt Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
The Convective Zt Histograms are histograms of corrected reflectivity factors for convective rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Strat. Zt Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
The Stratiform Zt Histograms are histograms of corrected reflectivity factors for stratiform rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Rain Rate Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
These are histograms of nonzero rain rate pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Rain Rate Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
These are histograms of nonzero rain rate pixels for convective rain at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767

Strat. Rain Rate Hist. (SDS, array size nlat x nlon x ncat1 x nh1, 2-byte integer):
These are histograms of nonzero rain rate pixels for stratiform rain at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767

PIA srt Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):
PIA srt Hist. gives histograms of path-attenuation as determined by the surface reference technique (SRT) at 4 incidence angles (0, 5, 10 and 15^0) for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

PIA hb Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):
These are histograms of path-attenuation using an estimate derived from measured reflectivity (Z_m) and a k-Z relationship at 4 incidence angles (0, 5, 10 and 15^0) for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

PIA 0th Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer)
PIA 0th Hist. is the histogram of the 0th order path-integrated attenuation with a horizontal resolution of 5^o x 5^o. This histogram is calculated for 30 categories at 4 different incident angles (0^o, 5^o, 10^o and 15^o). It ranges from 0 to 32,767

Zm Gradient Hist. (SDS, array size nlat x nlon x ncat2 x nh2, 2-byte integer):
These are histograms of the vertical gradient in measured reflectivity at 3 levels for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Xi Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
The Xi Histograms is the histogram of non-uniformity parameter determined in 2A-25 for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

NUBF Hist. (SDS, array nlat x nlon x ncat2, 2-byte integer)
NUBF(Non-Uniform Beam Filling) Hist. gives the histogram of the NUBF correction for Z-factor and rain rate of 30 different categories over 5^o x 5^o grid boxes. It ranges from 0 to 32,767.

ZPZM Hist. (SDS, array nlat x nlon x ncat2, 2-byte integer)
ZPZM Hist. is the histogram of the difference between the reflectivity at two heights: (Bright Band - Epsilon) and (Bright Band + Epsilon). This histogram is calculated for 30 different categories at each grid box of 5^o x 5^o. It ranges from 0 to 32,767.

RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):
These are correlation coefficients of nonzero rain rates between 3 heights (i.e., correlation coefficient of rain rates at 2km vs 4km , 2km vs 6km , and 4km vs 6km) for a 5° x 5° box for one month. They are calculated under convective condition, stratiform condition or both. It ranges from -1.000 to 1.000.

Conv. RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):
These are correlation coefficients of nonzero rain rates for convective rain between 3 heights (i.e., correlation coefficient of rain rates at 2km vs 4km , 2km vs 6km , and 4km vs 6km) for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

Strat. RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):

These are correlation coefficients of nonzero rain rates for stratiform rain between 3 heights (i.e., correlation coefficient of rain rates at 2km vs 4km , 2km vs 6km , and 4km vs 6km) for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

Hgt. and Zm Corr. Coef. (SDS, array size nlat x nlon, 4-byte float):
This is the correlation coefficient between the storm height and the maximum measured reflectivity factor along the path for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

PIAs Corr. Coef. (SDS, array size nlat x nlon x nang x 3, 4-byte float):
This is the correlation coefficient of three path-integrated attenuations (SRT, HB, and 0th order PIAs) at angles of 0^0, 5^0, 10^0 and 15^0 for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

Xi and Zm Corr. Coef. (SDS, array size nlat x nlon, 4-byte float):
This is the correlation coefficient between the non-uniformity and the maximum measured reflectivity factor along the path for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

GridStructure 2 (Attribute, 5000-byte character):
GridStructure 2 gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh2, 4-byte float):
Rain Rate Mean 2 gives means of nonzero rain rates over 0.5^0 x 0.5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2, 4, and 6 km. It ranges from 0 to 3000.0 mm/h.

Rain Rate Dev. 2 (SDS, array size nlath x nlonh x nh2, 4-byte float):
Rain Rate Dev. 2 gives standard deviations of nonzero rain rates over 0.5^0 x 0.5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2, 4, and 6 km. It ranges from 0 to 3000.0 mm/h.

Conv. Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh2, 4-byte float):
Conv. Rain Rate Mean 2 gives means of nonzero rain rates for convective rain over 0.5^0 x 0.5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2, 4, and 6 km. It ranges from 0 to 3000.0 mm/h.

Conv. Rain Rate Dev. 2 (SDS, array size nlath x nlonh x nh2, 4-byte float):
Conv. Rain Rate Dev. 2 gives standard deviations of nonzero rain rates for convective rain over 0.5^0 x 0.5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2, 4, and 6 km. It ranges from 0 to 3000.0 mm/h.

Strat. Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh2, 4-byte float):
Strat. Rain Rate Mean 2 gives means of nonzero rain rates for stratiform rain over 0.5^0 x 0.5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2, 4, and 6 km. It ranges from 0 to 3000.0 mm/h.

Strat. Rain Rate Dev. 2 (SDS, array size nlath x nlonh x nh2, 4-byte float):
Strat/ Rain Rate Dev. 2 gives standard deviations of nonzero rain rates for stratiform rain over 0.5^0 x 0.5^0 boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2, 4, and 6 km. It ranges from 0 to 3000.0 mm/h.

Zm Mean 2 (SDS, array nlath x nlonh x nh2, 4-byte float)
Zm Mean 2 gives the monthly means of the measured reflectivity at 3 fixed height levels (2, 4 and 6 km) over 0.5^o x 0.5^o grid boxes. It ranges from -20 to 80 dBZ.

Conv. Zm Mean 2 (SDS, array nlath x nlonh x nh2, 4-byte float)
Conv. Zm Mean 2 gives the monthly means of the measured reflectivity of convective rain at 3 fixed height levels (2, 4, and 6 km) over 0.5^o x 0.5^o grid boxes. It ranges from -20 to 80 dBZ.

Strat. Zm Mean 2 (SDS, array nlath x nlonh x nh2, 4-byte float)
Strat. Zm Means gives the monthly means of the measured reflectivity of stratiform rain at 3 fixed heights (2, 4, and 6 km) over 0.5^o x 0.5^o grid boxes. It ranges from -20 to 80 dBZ.

Zt Mean 2 (SDS, array nlath x nlonh x nh2, 4-byte float)
Zt Mean 2 gives the monthly means of the corrected reflectivity at 3 fixed heights (2, 4, and 6 km) over 0.5^o x 0.5^o grid boxes. It ranges from 0.1 to 80 dBZ.

Conv. Zt Mean 2 (SDS, array nlath x nlonh x nh2, 4-byte float)
Conv. Zm Mean 2 gives the monthly means of the corrected reflectivity of convective rain at 3 fixed height levels (2, 4, and 6 km) over 0.5^o x 0.5^o grid boxes. It ranges from 0.1 to 80 dBZ.

Strat. Zt Mean 2 (SDS, array nlath x nlonh x nh2, 4-byte float)
Strat. Zm Means gives the monthly means of the corrected reflectivity of stratiform rain at 3 fixed heights (2, 4, and 6 km) over 0.5^o x 0.5^o grid boxes. It ranges from 0.1 to 80 dBZ.

Storm Height Mean (SDS, array nlath x nlonh x 3, 4-byte float)
Storm Height Mean gives the monthly means of the storm height, unconditioned and conditioned for stratiform and convective rain over 0.5^o x 0.5^o grid boxes. It has units of meters and ranges from 0 to 20,000.

BB Height Mean (SDS, array nlath x nlonh, 4-byte float)
BB Height Mean gives the monthly means of bright-band height over grid boxes of 0.5^o x 0.5^o. It has units of meters and ranges from 0 to 20,000.

Total Pixel Number 2 (SDS, array size nlath x nlonh, 4-byte integer):
The Total Pixel Number 2 is the number of total pixels over 0.5^0 x 0.5^0 boxes for one month. The range is 0 to 2,000,000.

Rain Pixel Number 2 (SDS, array size nlath x nlonh x nh3, 4-byte integer):

The Rain Pixel Number 2 is the monthly number of nonzero rain rate pixels for path-averaged rainfall and rainfall at the fixed heights of 2, 4, and 6 km over 0.5^0 x 0.5^0 boxes. The range is 0 to 2,000,000.

Conv. Rain Pixel Number 2 (SDS, array size nlath x nlonh x nh2, 4-byte integer):
The Convective Rain Pixel Number 2 is the number of nonzero rain rate pixels for convective rain at the fixed heights of 2, 4, and 6 km over 0.5^0 x 0.5^0 boxes for one month. The range is 0 to 2,000,000.

Strat. Rain Pixel Number 2 (SDS, array size nlath x nlonh x nh2, 4-byte integer):
The Stratiform Rain Pixel Number 2 is the number of nonzero rain rate pixels for stratiform rain at the fixed heights of 2, 4, and 6 km over 0.5^0 x 0.5^0 boxes for one month. The range is 0 to 2,000,000.

2.2.2 3A-26 - Surface Rain

3A-26, “Surface Rain”, computes the distribution of rainfall on a 5° x 5° grid on a monthly basis. The output products are calculated at three fixed heights (2, 4 and 6 km) and for the path-averaged rain rates. 3A-26 will also compute fitting parameters for cumulative probability functions of rain rate as a function of 20 rain categories and 6 thresholds. Figure 2.2.2-1 shows the structure of the 3A-26 product in terms of the component objects and their sizes.

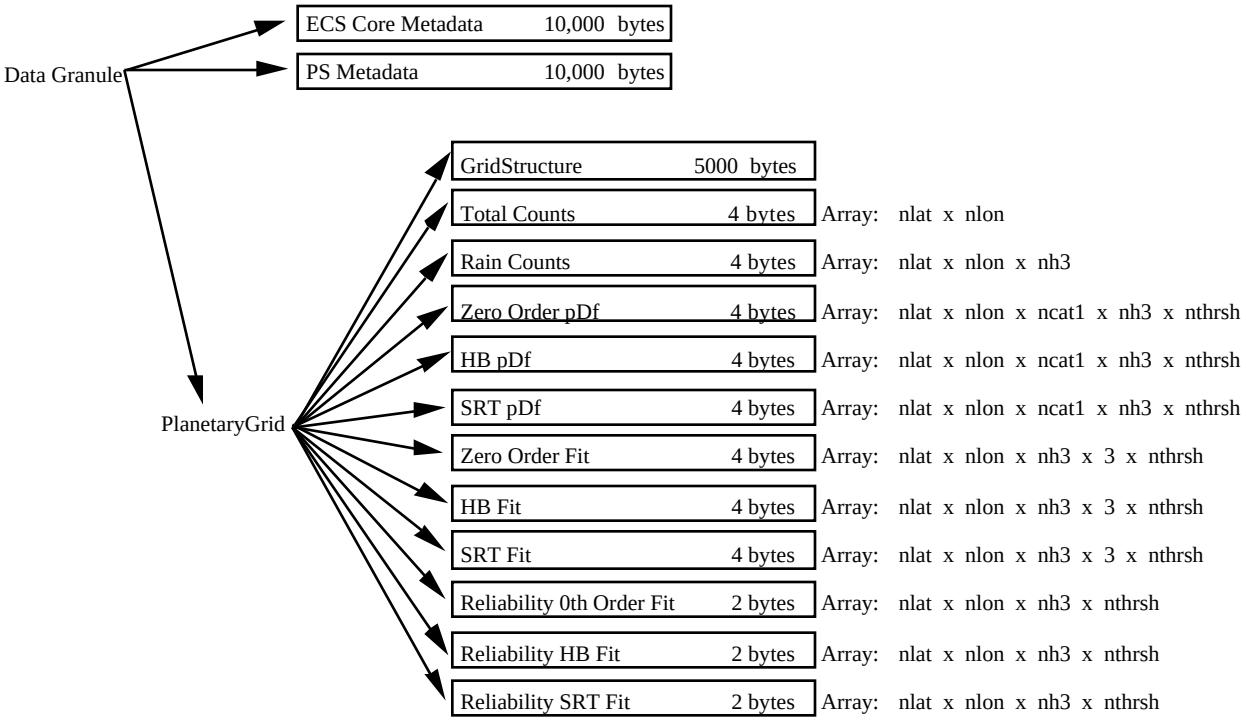


Figure 2.2.2-1
Data Format Structure for 3A-26, Surface Rainfall.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

Grid Structure (Vdata Table, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Total Counts (SDS, array size nlat x nlon, 4-byte integer):

This is the total number of counts (measurements) per month at each 5° x 5° box. Ranges are 0 to 2,147,483,647.

Rain Counts (SDS, array size nlat x nlon x nh3, 4-byte integer):
Total number of rain counts per month at each 5° x 5° box. This is computed for the surface, at 2km and 4km and for the path-average. Ranges are 0 to 2,147,483,647.

Zero Order pDf (SDS, array size nlat x nlon x ncat1 x nh3 x nthrsh, 4-byte integer):
Probability distribution function (cumulative) in counts of the zeroth order rain rate estimate at each 5° x 5° box. The pDf is computed for the surface, at 2km and 4km and for the path average. Ranges are 0 to 2,147,483,647.

HB pDf (SDS, array size nlat x nlon x ncat1 x nh3 x nthrsh, 4-byte integer):
Probability distribution function (cumulative) in counts of the Hitschfield-Bordan (HB) rain rate estimate at each 5° x 5° box. The pDf is computed for the surface, at 2km and 4km and for the path average. Ranges are 0 to 2,147,483,647.

SRT pDf (SDS, array size nlat x nlon x ncat1 x nh3 x nthrsh, 4-byte float):
Probability distribution function (cumulative) in counts of the Surface Reference Technique (SRT) rain rate estimate at each 5° x 5° box. The pDf is computed for the surface, at 2km and 4km and for the path average. Ranges are 0 to 2,147,483,647.

Zero Order Fit (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):
The mean, variance and probability of rain parameters for the log-normal model obtained from the zeroth order pDf. Fitting parameters are given for the surface, at 2km and 4km and for the path average. In addition, 5 thresholds are used. Ranges are **TBD**.

HB Fit (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):
The 3 fitting parameters for the log-normal model obtained from the HB pDf. Fitting parameters are given for the surface, at 2km and 4km and for the path average. In addition, 5 thresholds. Ranges are **TBD**.

SRT Fit (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):
The 3 fitting parameters for the log-normal model obtained from the SRT pDf. Fitting parameters are given for the surface, at 2km and 4km and for the path average and for 5 thresholds. Ranges are **TBD**.

Reliability 0th Order Fit (SDS array size nlat x nlon x nh3 x nthrsh, 2-byte integer):
Reliability parameter for the 0th order fit. Units and ranges are **TBD**.

Reliability HB Fit (SDS arraysize nlat x nlon x nh3 x nthrsh, 2-byte integer):
Reliability parameter for the HB fit. Units and ranges are **TBD**.

Reliability SRT Fit (SDS array size nlat x nlon x nh3 x nthrsh, 2-byte integer):
Reliability parameter for the SRT fit. Units and ranges are **TBD**.

2.3 TMI AND PR COMBINED

There is one Level 3 combined algorithm for TMI and PR, 3B-31 - Rainfall Combined (PI: Dr. Christian Kummerow). The granule size is one month. The following parameters are used in describing the formats:

- nlat: the number of 5° grid intervals of latitude from 40° N to 40° S (16).
- nlon: the number of 5° grid intervals of longitude (72).
- nlayer: the number of profiling layers (14).

2.3.1 3B-31 - Rainfall Combined

3B-31, "Rainfall Combined", uses the high quality retrievals done for the narrow swath in 2B-31 to calibrate the wide swath retrievals generated in 2A-12. For each 5° x 5° latitude/longitude box and each vertical layer, an adjustment ratio will be calculated for the swath overlap region for one month which will then be applied to the 2A-12 product to produce monthly means. Figure 2.3.1-1 shows the structure of the 3B-31 product in terms of the component objects and their sizes.

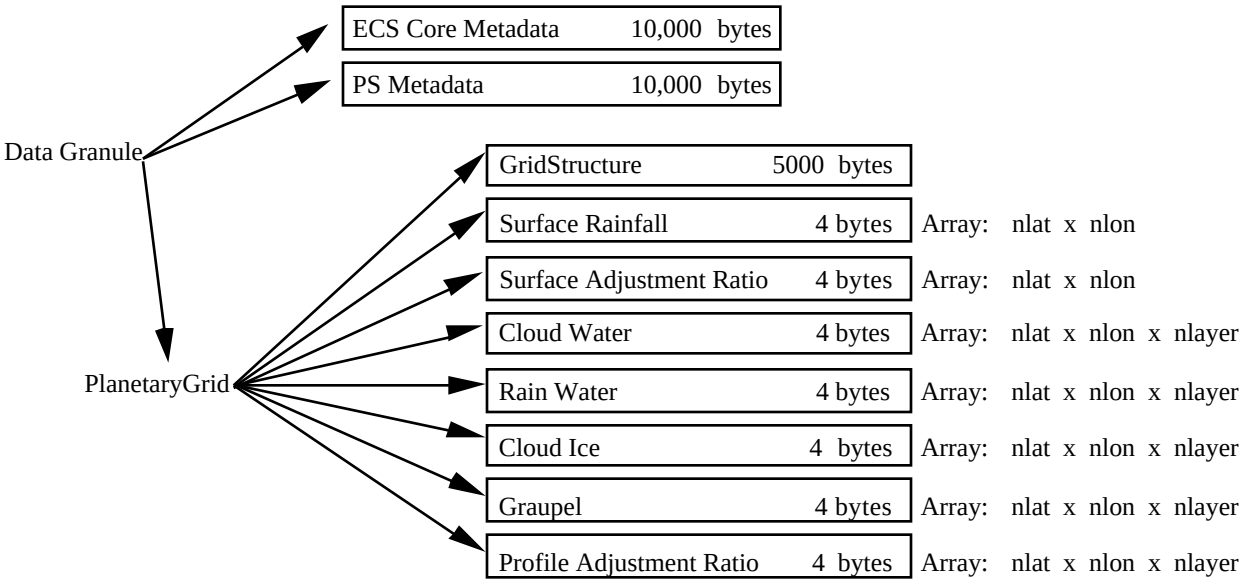


Figure 2.3.1-1
Data Format Structure for 3B-31, Rainfall Combined.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Surface Rainfall (SDS, array size nlat x nlon, 4-byte float):

The Surface Rainfall is the surface rain accumulation in 5° x 5° boxes. It ranges from 0.0 to 3000.0 mm.

Surface Adjustment Ratio (SDS, array size nlat x nlon, 4-byte float):

The Surface Adjustment Ratio is calculated from the swath overlap region for each 5° x 5° box.

Cloud Water (SDS, array size nlat x nlon x nlayer, 4-byte float):

The cloud water is that at each vertical layer in each 5° x 5° box for one month. It ranges from 0.0 to 1000.0 g m^{-3}.

Rain Water (SDS, array size nlat x nlon x nlayer, 4-byte float):

The rain water is that at each vertical layer in each 5° x 5° box for one month. It ranges from 0.0 to 1000.0 g m^{-3}.

Cloud Ice (SDS, array size nlat x nlon x nlayer, 4-byte float):

The cloud ice is that at each vertical layer in each 5° x 5° box for one month. It ranges from 0.0 to 1000.0 g m^{-3}.

Graupel (SDS, array size nlat x nlon x nlayer, 4-byte float):

The graupel is that at each vertical layer in each 5° x 5° box for one month. It ranges from 0.0 to 1000.0 g m^{-3}.

Profile Adjustment Ratio (SDS, array size nlat x nlon x nlayer, 4-byte float):
The Profile Adjustment Ratio is the adjustment ratio for each vertical layer. The ratio is calculated from the swath overlap region for each 5° x 5° box.

2.4 TRMM AND OTHERS COMBINED

There are two TRMM and Others Combined algorithms, 3B-42 - TRMM and Others-GPI Calibration (PI: Dr. Robert Adler and Dr. George Huffman), and 3B-43 - TRMM and Others Data Sources (PI: Dr. Robert Adler and Dr. George Huffman). The formats of these products are based on the Version 1 algorithm descriptions. The granule size is 5 days. The following parameters are used in describing the formats:

- nlat: the number of 1° grid intervals of latitude from 40° N to 40° S (80).
- nlon: the number of 1° grid intervals of longitude (360).

2.4.1 3B-42 - TRMM and Others GPI Calibration

3B-42, "TRMM and Others GPI Calibration", provides precipitation estimates in the TRMM regions that have the (nearly-zero) bias of the "TRMM Combined Instrument" precipitation estimate and the dense sampling of geosynchronous IR imagery. Figure 2.4.1-1 shows the structure of the 3B-42 product in terms of the component objects and their sizes.

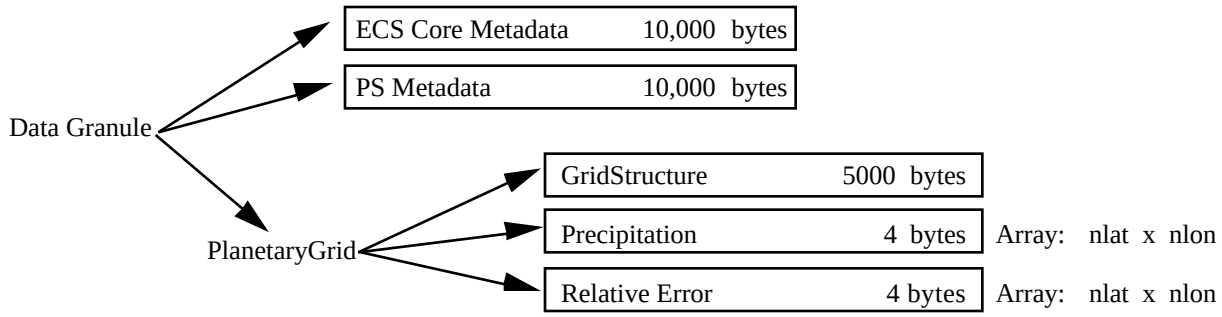


Figure 2.4.1-1
Data Format Structure for 3B-42, TRMM and Others GPI Calibration.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Precipitation (SDS, array size nlat x nlon, 4-byte float):

This is the adjusted GPI precipitation estimate at each 1° x 1° box for 5 days. It ranges from 0.0 to 400.0 mm.

Relative Error (SDS, array size nlat x nlon, 4-byte float):

This is the adjusted GPI relative error estimate at each 1° x 1° box for 5 days. It ranges from 0.0 to 10.0 mm.

2.4.2 3B-43 - TRMM and Others Data Sources

3B-43, "TRMM and Others Data Sources", provides a "best" precipitation estimate in the TRMM region from all global data sources, namely TRMM, geosynchronous IR, SSM/I microwave, and rain gauges. Figure 2.4.2-1 shows the structure of the 3B-43 product in terms of the component objects and their sizes.

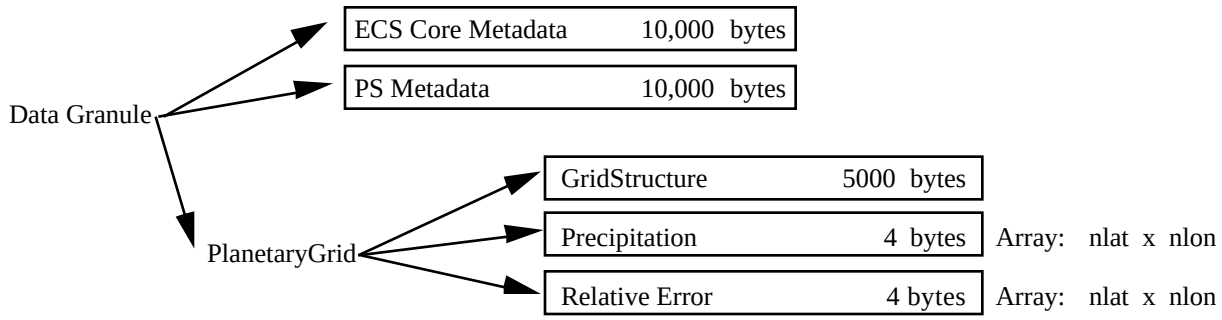


Figure 2.4.2-1
Data Format Structure for 3B-43, TRMM and Other Data Sources

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Precipitation (SDS, array size nlat x nlon, 4-byte float):

This is the satellite/gauge precipitation estimate at each 1° x 1° box for 5 days. It ranges from 0.0 to 400.0 mm.

Relative Error (SDS, array size nlat x nlon, 4-byte float):

This is the satellite/gauge relative error estimate at each 1° x 1° box for 5 days. It ranges from 0.0 to 10.0 mm.

2.5 GV RADAR

There are three Level 3A products for GV radar, 3A-53 ¾ 5-Day Site Rainfall Map (PI: Dr. Robert Houze), 3A-54 ¾ Site Rainfall Map (PI: Dr. Robert Houze) and 3A-55 ¾ Monthly 3-D Structure (PI: Dr. Robert Houze). The formats of these products are based on the Version 1 algorithm descriptions and consultation with GV radar algorithm scientists. The granule size is 5 days for 3A-53 and one month for 3A-54 and 3A-55. The following parameters are used in describing the format:

- nx_prod: the number of points in the x-dimension of a 3-D Cartesian grid; 151 for single radar sites; 363 for the multiple radar site in Texas and 257 for Florida multiple radar site;
- ny_prod: the number of points in the y-dimension of a 3-D Cartesian grid; 151 for single radar sites; 285 for the multiple radar site in Texas and 353 for Florida multiple radar site;
- nz: the number of grid points in the z-dimension of a 3-D Cartesian grid; 13 for both single and multiple radar sites;
- ncat: the number of categories for computing CFADs and vertical profiles. There are totally 12 categories (eg., stratiform precipitation, convective precipitation, water surface, and land, etc.) that are enumerated in each section where applicable;
- nbin: the maximum number of reflectivity bins; this is 86 which will allow a reflectivity range of -15 to 70 dBZ incremented by 1 dBZ.

2.5.1 3A-53 - 5-Day Site Rain Map

3A-53, "5-Day Site Rain Map", is a map of 5-day surface rain totals derived from the instantaneous rain rate maps (2A-53). The map is in Cartesian coordinates with a 2 km horizontal resolution. It covers an area of 300km x 300km at single radar sites while the area differs for the multiple radar sites - 724km x 568km at the Texas site and 512km x 704km at Florida site. It should be noted that this is not a simple accumulation of the instantaneous maps as gaps in the data must be factored into the calculation. Figure 2.5.1-1 shows the structure of the 3A-53 product in terms of the component objects and their sizes.

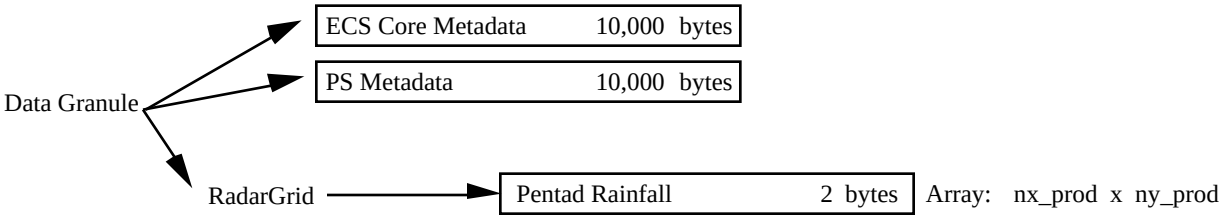


Figure 2.5.1-1
Data Format Structure for 3A-53, 5-Day Site Rain Map.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

Pentad Rainfall (SDS, array size nx_prod x ny_prod, 2-byte integer):
Pentad Rainfall is a map of the 5-day rainfall totals as derived from the instantaneous rain rate maps. The maps are in Cartesian coordinates with a 2 km horizontal resolution. They cover a region of 300km x 300km at single radar sites while the covered area differs for the multiple radar sites, i.e., 724km x 568km at Texas site and 512km x 704km at Florida site. As mentioned previously, this is not a simple accumulation of the instantaneous maps due to the presence of gaps in the data. The method used to handle the gaps is still **TBD**. The rainfall ranges from 0.0 to 5,000.0 mm. It is multiplied by 10 and stored as a 2-byte integer.

2.5.2 3A-54 - Site Rainfall Map

3A-54, "Site Rainfall Map", is a map of monthly surface rain totals derived from the instantaneous rain rate maps (2A-53). The map is in Cartesian coordinates with a 2 km horizontal resolution and covers an area of 300km x 300km at single radar sites while the covered area varies for multiple radar sites - 724km x 568km at Texas site and 512km x 704km at Florida site. This monthly rainfall map is not a simple accumulation of the instantaneous maps as gaps in the data must be factored into the calculation. Figure 2.5.2-1 shows the structure of the 3A-54 product in terms of the component objects and their sizes.

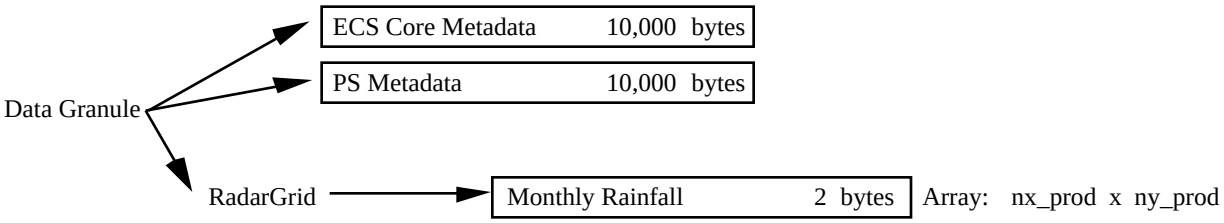


Figure 2.5.2-1
Data Format Structure for 3A-54, Site Rainfall Map.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

Monthly Rainfall (SDS, array size nx_prod x ny_prod, 2-byte integer):
Monthly Rainfall is a map of the monthly rainfall totals as derived from the instantaneous rain rate maps. The maps are in Cartesian coordinates with a 2 km horizontal resolution and cover an area of 300km x 300km at single radar sites, 724km x 568km at Texas multiple radar site and 512km x 704km at Florida multiple radar site. This monthly rainfall map is not a simple accumulation of the

instantaneous maps due to the presence of gaps in the data. The method used to handle the gaps is still **TBD**. The rainfall ranges from 0.0 to 10,000.0 mm.

2.5.3 3A-55 - Monthly 3-D Structure

3A-55, "Monthly 3-D Structure", provides radar site monthly 3-D structure information obtained from 2A-55. Figure 2.5.3-1 shows the structure of the 3A-55 product in terms of the component objects and their sizes.

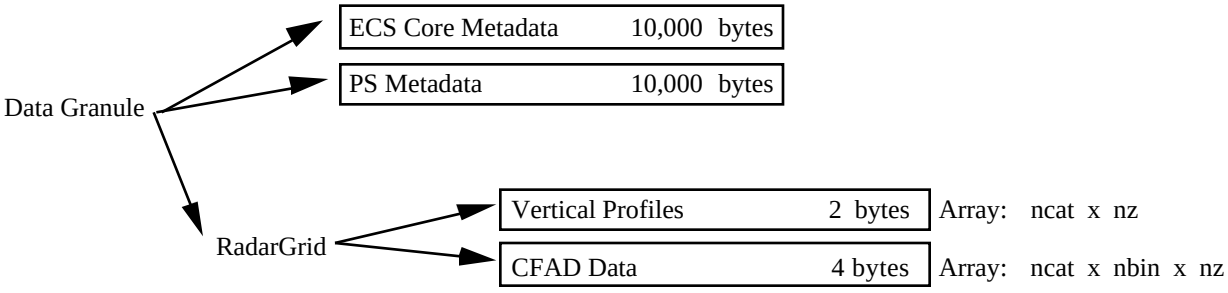


Figure 2.5.3-1
Data Format Structure for 3A-55, Monthly 3-D Structure.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

Vertical Profiles (SDS, array size ncat x nz, 2-byte integer):
The vertical profiles are computed at each analysis level for a month for the following categories:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) "anvil" (Anvil is defined as echo aloft with no contribution to surface rain.);
11) "anvil" over land;
12) "anvil" over sea.

Values range from -15.00 to 70.00 dBZ and are multiplied by 100 and stored as 2-byte integers.

CFAD Data (SDS, array size ncat x nbin x nz, 4-byte integer):

The CFAD Data are the number of pixels counted in specified height-reflectivity bin pairs for the 12 categories listed below for a month of radar data. Values range from 0 to 68,403,000 (3,000 radar volumes/month x 151 x 151) for single radar sites and from 0 to 310,365,000 (3,000 x 363 x 285) for Texas multiple radar site, from 0 to 272,163,000 (3,000 x 257 x 353) for Florida multiple radar site. The 12 categories are:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) “anvil” (Anvil is defined as echo aloft with no contribution to surface rain.);
11) “anvil” over land;
12) “anvil” over sea.

2.6 OTHER VALIDATION DATA

There are 4 other Level 3 validation data products. Of those, only 3A-46 ¾ SSM/I Rain (PI: Dr. Robert Adler, Dr. George Huffman) will be used by TSDIS for data processing. The granule size is one month. The following parameters are used in describing the formats:

- nlat: the number of 1.0° grid intervals of latitude from 90° N to 90° S (180).
- nlon: the number of 1.0° grid intervals of longitude (360).

2.6.1 3A-46 - SSM/I Rain

3A-46, “SSM/I Rain”, produces a 1.0° x 1.0° monthly rainfall map using SSM/I data. Figure 2.6.1-1 shows the structure of the 3A-46 product in terms of the component objects and sizes.

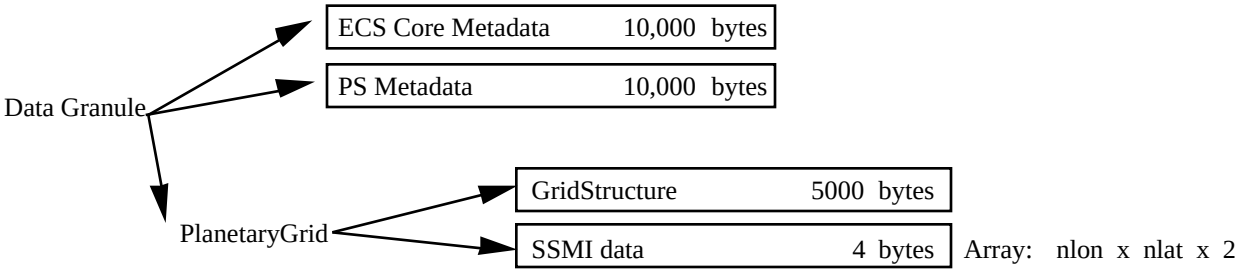


Figure 2.6.1-1
Data Format Structure for 3A-46, SSM/I Rain.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):

ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Appendix A in Volume 3 of ICS, Level 1 File Specifications.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Appendix B in Volume 3 of ICS, Level 1 File Specifications.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications. Exceptions to the values in Section 2 are noted in Table 2.6.1-1.

Table 2.6.1-1
3A-46 GridStructure Fields

Name	Value
Latitude Resolution	1
Longitude Resolution	1
North Bounding Coordinate	90
South Bounding Coordinate	-90
West Bounding Coordinate	0
East Bounding Coordinate	360
Origin	“NORTHWEST”

SSMIdata (SDS, array size nlon x nlat x 2, 4-byte float):

SSMI data averaged over 1° x 1° grid boxes and one month. The first variable is Precipitation Rate (mm/hr); the range is 0 to 100. The second variable is Number of Observations; the range is 0 to one billion. Note that the grids in SSMIdata are different than the standard TSDIS grids in the following ways:

1) The longitude dimension precedes the latitude dimension.
2) The longitude index begins at the Greenwich meridian.
3) The latitude index begins at the northernmost row.
4) The latitude range is -90 to +90.

3. ACRONYMS

C

CA	Closest Approach
CAMS	Climate Assessment and Monitoring System
CFAD	Contoured Frequency by Altitude Diagram

D

DMSP	Defense Meteorological Satellite Program

E

ECS	EOSDIS Core System
EOSDIS	Earth Observing System Data and Information System

F

FOV	Field of View

G

GOES	Geostationary Operational Environmental Satellite
GPCC	Global Precipitation Climatological Center
GPCP	Global Precipitation Climatological Project
GPI	GOES Precipitation Index
GV	Ground Validation

H

HB	Hitschfeld Bordan Technique

I

ICS	Interface Control Specification
IFOV	Instantaneous Field of View

N

NUBF	Non-Uniform Beam Filling

P

PI	Principal Investigator
PIA	Path Integrated Attenuation
PR	Precipitation Radar
PS	Product Specific

R

RR	Rain Rate

S

SDS	Science Data Set
SRT	Surface Reference Technique
SSM/I	Special Sensor Microwave/Imager

T

TBD	To Be Determined

TMI	TRMM Microwave Imager
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
TSU	TSDIS Science Users

U

UTC	Universal Time Coordinated

V

VIRS	Visible and Infrared Scanner

4. GLOSSARY

Convective rain	Precipitation from a convective cloud with extensive vertical development.
Disdrometer	Equipment designed to measure and record the size distribution of raindrops.
Earth Ellipsoid	An imaginary surface of the earth in the shape of an ellipsoid that coincides with the Mean Sea Level.
Geoid	An imaginary surface of the earth that coincides with Mean Sea Level over oceans and is extended through continents.
Granule	The amount of information contained in one data file (e.g., one orbit for some satellite data or one hour for some ground validation data).
Graupel	Compact precipitating ice, smaller than hail.
Isotherm	A contour of equal or constant temperature.
Metadata	Information which describes a data set (e.g., date recorded, source, or purpose).
Nadir	The point on the earth directly below the satellite.
Planetary Grid Structure	An EOSDIS defined structure in HDF to store data organized in one of the planetary grids defined by EOSDIS.
Radar Grid Structure	A user defined structure in HDF to store data organized in a grid with constant distance spacing on the surface of the earth.
Radar Structure	A user defined structure in HDF to store data organized in original ground radar spherical geometry.
Scan	A single sweep of a sensor onboard a satellite
Stratiform rain	Precipitation from a stratiform cloud with extensive horizontal development.
Swath Structure	An EOSDIS defined structure in HDF to store data organized by scans.
Vdata	An HDF object that is a table of records.
Vgroup	An HDF group of objects or other Vgroups.
Z-R relationship	A relationship between radar reflectivity (Z in mm^6/m^3) and rain rate (R in mm/hr)